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(71) Applicant:

Ludowici, Michael Christian, 8013 Haar, DE

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(75) Inventor:
as Applicant

(54) *Device for generating heating*

Michael Christian Ludowici
Josef Wiesbergerstraße 5-7
8013 Haar bei München

Device for generating heating

Claims

1. Device for generating heating from environmental energy using a roof having overlapping roof-covering elements, in which a pipe system is laid for a fluid absorbing the environmental energy, and at least one part of which has layers of supporting plates laid like roof tiles and roof-covering elements developed as cover plates, the pipe system being fitted to the topside of the supporting plates, and the cover plates being laid with each other and with the adjacent normal roof-covering elements in the manner of roof tiles (according to Patent ...., Patent Application P 29 40 896.6), characterized in that the supporting and/or cover plates (22, 12) have channels (1221, 2211) orientated transversely to the direction of the rafters (521), to house the pipe system (411).

2. Device according to claim 1, characterized in that the channels (1221, 2211) run kink-free over their whole length.

3. Device according to claim 1 or 2, characterized in that the channels run kink-free over the whole width (in the direction of the roof battens) of the plates (12, 22).

4. Device according to at least one of claims 1 to 3, characterized in that the channels (1221, 2211) of adjacent, laid supporting or cover plates (22, 12) in each case open into one another at the same level and kink-free.

5. Device according to at least one of claims 1 to 4, characterized in that each supporting plate (22) has a side-rabbet and top-rabbet part (2223, 2224),

sunken so far that the channels (2211) can extend at the same level over the whole cover-rabbet part (224).

6. Device according to at least one of claims 1 to 5, characterized in that collecting pipes (44) of the pipe system (411) run parallel to the rafters.

7. Device according to at least one of claims 1 to 6, characterized in that the collecting pipes (44) of the pipe system (411) in hipped roofs run in the hips.

8. Device according to at least one of claims 1 to 7, characterized in that the foot-rabbet part (226) of each supporting plate (22) is formed level on its underside and in the laid state lies on a level bearing surface (2255) of the head-rabbet part (225) of an overlapped supporting plate (22).

9. Device according to at least one of claims 1 to 8, characterized in that the foot-rabbet part (226) of the supporting plate (22) is formed level on its topside and in the laid state the cover plate (12) essentially located above the overlapped supporting plate lies on the level topside of the foot-rabbet part of the adjacent ridge-side supporting plate.

10. Device according to at least one of claims 1 to 9, characterized in that the foot part (226) of each supporting plate lies against the topside of the head part (225) of the cover plate (11) following on the eaves side.

11. Device according to at least one of claims 1 to 10, characterized in that the head part (125) of each cover plate lies on the head part (225) of the supporting plate (11) located beneath it.

12. Device according to at least one of claims 1 to 11, characterized in that a head-rabbet groove (2252) is arranged between centring head (2256) and middle field, opening out at the same level into the side-rabbet groove (2232).

13. Device according to at least one of claims 1 to 12, characterized in that the lower level of the head-rabbet groove (2252) opens out at the same level into

the side-rabbet groove in the area of the head-side-rabbet angle, but then rises slightly in the direction of the head-top-rabbet angle.

14. Device according to at least one of claims 1 to 13, characterized in that the head part (225) of the supporting plate (22) has ribs (2251) projecting over the level of same.

15. Device according to at least one of claims 1 to 14, characterized in that the supporting plates (22) in the head part (225) have an upwardly projecting centring head (2256) which in the laid state engages in a recess (2267) of the overlapping supporting plate (22).

16. Device according to at least one of claims 1 to 15, characterized in that the centring head (2256) on the bearing surface (2255) of the head-rabbet part (225) is moved so far in the direction of the eaves that a free space remains free on the ridge side to house a suspension lug (1254) of the overlapping cover plate (12).

17. Device according to at least one of claims 1 to 16, characterized in that the width of the centring head (2256) in the direction of the roof battens is at least one-and-a-half times greater than its depth in the direction of the rafters.

18. Device according to at least one of claims 1 to 17, characterized in that the recess (2267) is rectangular and the longer rectangle sides are arranged parallel to the direction of the roof battens.

19. Device according to at least one of claims 1 to 18, characterized in that the recess (2267) is only slightly wider than the centring head (2256).

20. Device according to at least one of claims 1 to 19, characterized in that the depth of the recess (2267) in the direction of the rafters corresponds at least to the depth of the centring head (2256) in the same direction plus the depth of the suspension lug (1254), also in the direction of the rafters, of the cover plate (12).

21. Device according to at least one of claims 1 to 20, characterized in that the recess (2267) is dimensioned to be so deep in the direction of the rafters that there is still a free space, behind the centring head (2256) and the suspension lug (1254), through which to pass a storm clamp.

22. Device according to at least one of claims 1 to 21, characterized in that each covering element (12) has channels (1221) on its underside (122), to house the pipe system, which are arranged transversely to the direction of the rafters and parallel to each other and to the direction of the roof battens and are arranged such that during tiling they, together with the channels (1221) of the supporting plate (22), form a duct-like cavity.

23. Device according to at least one of claims 1 to 22, characterized in that the pipe system (41) comprises straight lines, such as tubes, pipes, hoses and the like.

24. Device according to at least one of claims 1 to 23, characterized in that several pipes (411) are combined into arrays (413).

25. Device according to at least one of claims 1 to 24, characterized in that the pipes (411) run parallel to each other and are connected with each other by means of connecting elements (4131) such as pins (4133), fish-plates (4134), sheets (4135) and the like.

26. Device according to at least one of claims 1 to 25, characterized in that there are ridges (2213, 1223) between the channels of the supporting and/or cover plates (22, 12).

27. Device according to at least one of claims 1 to 26, characterized in that cut-outs (2217) are arranged in the ridges (2213, 1223) of the covering and/or supporting plates (12, 22) to house the connecting elements (4131).

28. Device according to at least one of claims 1 to 27, characterized in that the connecting elements (4135) extend continuously over the entire length of the pipes (4411).

29. Device according to at least one of claims 1 to 28, characterized in that the cut-outs (2217) of the ridges (2213, 1221) extend over their entire length.

30. Device according to at least one of claims 1 to 29, characterized in that the underside of each cover plate (12) runs in its head-rabbet area at the same level to the first head-side channel (1221).

31. Device according to at least one of claims 1 to 30, characterized in that the bearing surface (2255) of the supporting plate (22) is sunken relative to its middle field (2221) and the thickness of the foot-rabbet part (226) of same is equal to the difference in height between the lowered bearing surface (2255) and the topside (221) of the middle field less the height of the ribs (2251).

32. Device according to at least one of claims 1 to 31, characterized in that the side-rabbet grooves (2232) of the supporting plates (22) lie in a line during overlapping.

33. Device according to at least one of claims 1 to 32, characterized in that, in order to achieve horizontal stackability, the head-rabbet part (225) is lowered so far that its lowering corresponds to the difference in height between the underside of the reinforcing ribs (2222) and the underside of the suspension lug (2221).

34. Device according to at least one of claims 1 to 33, characterized in that the side-rabbet groove (2232) of the supporting plate (12) rises somewhat from the eaves-side end.

35. Device according to at least one of claims 1 to 34, characterized in that the individual parts of the device, such as cover plates, pipe system etc., are held, instead of roof battens, by holding devices (522, 533) at a distance from the

roof sub-structure, there being a free space for the free circulation of air between the plates and the holding devices on the one hand and the roof sub-structure on the other hand.

36. Device according to at least one of claims 1 to 35, characterized in that the holding devices (522) are developed as U-shaped profiles or profiled sections.

37. Device according to at least one of claims 1 to 36, characterized in that when the roof is fully tiled the U-shaped profiled sections are aligned with their profile direction in the direction of the roof battens.

38. Device according to at least one of claims 1 to 37, characterized in that when the roof is tiled the U-shaped profiled sections are aligned with their U opening towards the eaves.

39. Device according to at least one of claims 1 to 38, characterized in that the holding devices (522) have a hole (5224) into which a storm clamp can be inserted.

40. Device according to at least one of claims 1 to 39, characterized in that, at their U-leg arranged at a distance from the roof sub-structure in the tiled stated, the profiled sections have a longitudinal hole (5223) in the direction of the rafters.

41. Device according to at least one of claims 1 to 40, characterized in that there is attached to holding devices (522) arranged side by side at a distance in the direction of the roof battens is a longitudinal track (533) connecting these.

42. Device according to at least one of claims 1 to 41, characterized in that the longitudinal track (533) is fixed, displaceable in the direction of the rafters, to the holding devices.

43. Device according to at least one of claims 1 to 42, characterized in that the longitudinal track (533) has longitudinal holes (534) transversely to the direction of the rafters for fixing thereof to the holding devices (522).

44. Device according to at least one of claims 1 to 43, characterized in that the longitudinal holes are shifted so far in the direction of the eaves that the longitudinal track (533), even when fully pushed down inside the longitudinal hole, the longitudinal track (533) side still projects with its ridge-side edge over the U-shaped profiles or profiled sections of the holding devices (522).

45. Device according to at least one of claims 1 to 44, characterized in that the tube arrays (413) consist of at least two sections (413a, 413b) arranged side by side.

46. Device at least according to claim 23, characterized in that the pipes (411) have a square or rectangular or cut trapezoidal or polygonal or circular or oval cross-section, the channels of the plates (12, 22) being correspondingly adapted to the respective pipe cross-section.

47. Device at least according to claim 46, characterized in that the pipes (411) with a level cross-section shape are aligned in the laid state such that in each case the longer sides of the cross-section shape run parallel to the middle field level of the plates.

48. Device according to at least one of claims 1 to 47, characterized in that two or more cover or supporting plates (12, 22) are developed in one piece with each other and in each case form a plate-like element.

49. Device according to at least one of claims 1 to 48, characterized in that the pipe system (411) and the supporting plates (22) are developed in one piece with each other.

50. Device according to at least one of claims 1 to 49, characterized in that the pipe system (411) has a level supporting sheet to which the pipes are fitted in the form of profiled sheets.

51. Device according to at least one of claims 1 to 50, characterized in that on the underside the supporting sheet has reinforcing ribs (41381) running in the direction of the rafters.

52. Device according to at least one of claims 1 to 51, characterized in that the supporting sheet rests on the one hand on the roof battens and on the other side against the head part of the underlapping cover plate (12).

53. Device according to at least one of claims 1 to 52, characterized in that the pipes (4111) are charged with fluid on the counter-current principle.

Description

The invention relates to a device for generating heating from environmental energy using a roof having overlapping roof-covering elements, in which a pipe system is laid for a fluid absorbing the environmental energy, and at least one part of which has layers of supporting plates laid like roof tiles and roof-covering elements developed as cover plates, the pipe system being fitted to the topside of the supporting plates, and the cover plates being laid with each other and with the adjacent normal roof-covering elements in the manner of roof tiles, according to Patent ...., Patent Application P 29 40 896.6.

In the solution according to the main patent the pipe system is constructed so that the fluid flows essentially parallel to the rafters. Only the collecting pipes run in the direction of the roof battens. Due to the roof-tile form of the supporting and cover plates, steps result in the pipe system, which, when inflexible pipes are used, make it necessary to adapt them to the steps.

The object of the present invention is to develop a device of the type mentioned at the start, such that an essentially rigid pipe system can also be used without adaptation.

This object is achieved according to the invention in that the supporting and/or cover plates have channels orientated transversely to the direction of the rafters, to house the pipe system.

Because the channels are aligned transversely to the direction of the rafters, i.e. in the direction of the roof battens, it is possible to avoid any steps which would otherwise be present for the pipe system. The channels can be designed and arranged so that channels of adjacent plates corresponding to one another are flush with one another and pass into one another at the same level and kink-free. This means that the individual pipes of the pipe system, however developed, in each case run in a straight line and can follow a contour line of the roof. It is therefore also directly possible to also use inflexible metal tubes as pipes without adaptation.

The collecting pipes of the pipe system can run in the direction of the rafters. Overall, the pipe system can be prefabricated as a unit and then fitted to the lower layer of supporting plates.

As regards the appearance and aesthetic effect of the roof, it is proposed for the cover plates that these are made from the same material as the other normal elements. Clay, concrete, asbestos cement etc. will be considered first of all. The same materials can also be used for the supporting plates. The invention is not restricted to the use of these materials. On the contrary, with a view to more favourable heat-transfer coefficients, other materials, such as e.g. metals, glass, plastics etc. can also be used. Metals are in particular suitable for the pipe system and/or supporting plates, as this material is, on the one hand, stable and, on the other hand, in particular promotes heat absorption. As neither the pipe system nor the supporting plates are visible once the roof is laid, in the case of these two elements the material with the most favourable heat-transfer coefficient can directly be used.

When the pipes are arranged in the direction of the rafters, convection can be exploited *inter alia*, in order to move the fluid. This no longer obtains when the pipes are laid in the direction of the roof battens. However, this fact is not that important, as the use of a circulation pump will be required in any case.

The channels can be present both in the supporting plates and in the cover plates or in one of the two plates. This means that there can also be supporting plates and cover plates which have no channels for the pipe system and therefore have level surfaces. The design of the pipe system can be correspondingly adapted to the desired form of the covering and supporting plates.

In order to be able to have the channels running essentially over the whole width of the supporting plates, in an advantageous development it is provided that each supporting plate has a side- and top-rabbet part which is sunken so far that the channels can extend at the same level over the whole top-rabbet part.

For the laying of the supporting and cover plates, and their allocation to each other, it is favourable if the supporting plates have, on a bearing surface of the head-rabbet

part, an upwardly projecting centring head which in the laid state engages in a recess of the overlapping supporting plate. The centring head serves to centre the supporting plates during tiling. It can also be used as an abutment for one or more suspension lugs of the cover plate to be arranged above same.

As the pipes of the pipe system run in the direction of the roof battens, the centring head and the recess can now be very much wider than in the case of pipes running in the direction of the rafters, because these do not run past the centring head and recess. This improves walk-on stability and, during production, the drying and firing behaviour. Because the pipes are arranged in the direction of the roof battens, and the possibility results of making the centring head as wide as possible in the direction of the roof battens, its depth in the direction of the rafters can be dimensioned smaller, as the wider centring head can still assume its task in anchoring the overlapping supporting or cover plates.

Because of the slim, but wide, design of the centring head, the suspension lug of the overlapping cover plates can also be kept slimmer. Both measures together make it possible to keep the foot-rabbet part of the supporting plate much shorter. The foot-rabbet part should, in its depth in the direction of the rafters, be at least equal to the recess. The depth of the recess must at least be dimensioned such that its depth is the sum of the depths of the centring head and suspension lug of the cover plate.

As the pipes now run in the direction of the roof battens, the drop from the middle field to the foot-rabbet part of the supporting plates can be very steep, i.e. at an angle of approximately 84°. Due to this measure and the abovementioned reduction in the depth of the head-rabbet part a considerable enlargement of the middle field part is possible. This enlargement directly benefits the collector or absorber surface area of the pipe system.

Because the pipe system is aligned in the direction of the roof battens and the middle field enlarged in the area of the foot-rabbet part of the supporting plates, the foot overlap of the cover plates by the supporting plates is also improved, thus improving heat generation in the foot area of the cover plates.

In order to be able to satisfactorily divert condensation or thaw water running off the surface of the cover plates into the side rabbeting of the cover plates, it is recommended to arrange, in the area of the level surface of the head-rabbet part, a groove which runs essentially parallel to the roof battens. Condensation and thaw water will essentially run down the surface of the supporting plates, but condensation or thaw water can also run down the back of the supporting plates. The water running to the rear will drip off at the foot-side end of the supporting plate onto the head part of the overlapping supporting plate. For this purpose it is only necessary to provide a corresponding gap which is determined by the arrangement and height of the ribs. The fact that condensation and thaw water run down the back in particular of clay roof tiles is due to the hydrophilic property of the burnt body and has long been exploited in roof tile designs. In the case of the "energy roof" this fact gains even greater significance, as here in particular pronounced hoarfrost formation is to be expected on the back of the supporting plates, because the roof must always be kept below the outside temperature by the fluid. When outside temperatures are around 0°C, the upper - and underside of the roof are then already at temperatures which can then lead to the formation of an ice layer. This ice layer will melt as the temperature rises and run down the back of the supporting plates in the form of thaw water.

As the intrinsic gradient of the tiles is still at least 12°, the thaw water which adheres to ice just as it does to clay runs down the back and drips off at the foot-side end of the supporting plates.

In order to divert this water into the side-rabbet groove, it is proposed to arrange a head-rabbet groove between the centring head and the raised middle field part.

In the case of the supporting plate according to the invention, the side-rabbet part is laid lower. This makes it possible for the side-rabbet groove also to be made lower, i.e. to increase the difference between side-rabbet rib and side-rabbet groove, which can considerably improve the condensation and thaw water absorptivity of the side-rabbet groove. The head-rabbet groove now runs into this side rabbet groove at the same level. In order to allow the thaw and condensation water collecting in the head-rabbet groove to run off, it is proposed either to allow the lower level of the head-rabbet groove to rise slightly from left to right, i.e. from side-rabbet part to top- rabbet

part, or have the side-rabbet groove not run exactly parallel to the direction of the roof battens, but drop slightly from the head-top-rabbet angle to the head-side-rabbet angle.

In an advantageous development of the invention the foot part of each supporting plate rests on the topside of the head-rabbet part of the cover plate following on the eaves side.

This results in any condensation and thaw water occurring being drained from the cover and supporting plates onto the overlapped cover plate or cover plates, namely those following on the eaves side. The same applies to any fluid escaping from the pipe system which emerges between the supporting and cover plates and is then diverted to the cover plates following on the eaves side.

As, with this design, the supporting plates at the foot-side end in each case rest against the head part of the cover plates following on the eaves side, in each case a continuous layer of cover plates along a contour line results, covered by a continuous layer of cover plates also running along a contour line. This is to be taken into account during tiling.

The pipes running transversely to the direction of the rafters are guided over the middle field, the head- and foot-rabbet areas being free of pipes. However, it is precisely the middle field in the device according to the invention that is particularly suitable for generating environmental energy, as the middle field is not doubly overlapped and, in addition, the relatively smallest body thickness can be achieved here.

In a favourable development of the invention it is provided that the pipes in each case are combined into arrays of several pieces. Such arrays facilitate laying.

It is advantageous if the pipes run parallel to each other and are connected to each other by means of connecting elements such as pins, sheets, strips, fish-plates etc. Such pipe arrays can be prefabricated and, depending on the design, can also be continuously cast.

Between the channels of the supporting and/or cover plates, ridges can in each case be arranged which virtually accompany the channels. Cut-outs can be provided in the ridges, to house the connecting elements.

The shape of the ridges and of any cut-outs present together with the form of the channels plays a major role in the transfer of heat from the covering and supporting plates to the pipe system. If the pipes are interconnected via connecting elements, it depends on the relative height dimensioning of the ridges, the channels, the pipe cross-section and the cut-outs how the cover plates rest on the pipe system on the one hand and the supporting plates on the other hand and the energy is transferred. When dimensioning the parts indicated above, it must be taken into account on the one hand that the latter must not rock on each other, and on the other hand must be strong enough to walk on. Finally, it is to be ensured that sufficient heat is transferred from the covering and supporting plates to the pipe system.

The transfer of energy from the cover plates to the supporting plates can take place via the pipes themselves and/or via the ridges. In the first case the ridges will be dimensioned short so that, even when the cover plates are loaded with more than their own weight, ridges allocated to each other do not come into contact with each other. The plates then touch the pipes and rest above the latter. In the second case the ridges of the plates are designed so high that, when covering and supporting plates are laid on one another, they touch and come to rest on one another. The ridges then delimit cavities, the volume of which is dimensioned such that the pipes therein have space with clearance. Provided that the pipes are held to each other by connecting elements, the ridges, the channels, the pipe cross-section and the cut-outs can be matched to one another such that the connecting elements are clamped between the ridges of the covering and supporting plates. The result is that, in the area of the ridges, a direct, low-loss heat transfer takes place between the plates on the one hand and the pipe system on the other hand, as the air gap in the ridge area is minimized. On the other hand the pipes are at least partially separated from the channels via an air gap and are therefore also safe from crushing even under the greatest load. In this case the energy in the ridge area is introduced into the pipe system by direct contact of the connecting

elements, whilst the heat transfer in the case of the pipes takes place via radiation and convection.

There is also the case, however, where the transfer of energy and heat from the covering and supporting plates to the pipe system takes place partly via the ridges and partly directly via the pipe system. This means that combinations of the above possibilities are also conceivable. Thus, e.g. the supporting plates can be provided only with channels without special ridges, whilst the cover plates have channels with pronounced ridges.

In such a case the transfer of energy from the ridges to the connecting elements of the pipe system and from there to the pipes themselves would take place on the supporting plates. This arrangement can of course also be chosen the other way round.

In order to increase the heat transfer via the connecting elements and the ridges, the width of both can also be made approximately equal to or greater than the width of the pipes.

In an advantageous development of the invention it is provided that the individual parts of the device, such as cover plates, pipe system etc. are held, instead of by roof battens, by holding devices at a distance from the roof sub-structure, a free space for the free circulation of air being present between the plates and the holding devices on the one hand and the roof sub-structure on the other hand.

The holding devices serve as spacers to the roof sub-structure. They replace the roof battens and improve the air circulation underneath the device. This is very advantageous, as with it, the energy absorption, e.g. through the supporting plates, can be increased from below. It is important that the air under the supporting plates can as far as possible flow unhindered along the underside of the plates.

The holding devices can be developed as U-shaped profiles or profiled sections. Such profiles are commercial products, the sections can be cut from the bar.

Holding devices arranged side by side in the direction of the roof battens can be connected to each other by a longitudinal track. The longitudinal track performs the

same function as a roof batten, but offers the additional advantage that it has a lower air resistance, even if it should have e.g. an L-shaped cross-section for reasons of stability.

In an advantageous development of the invention the pipes have a square or rectangular or cut trapezoidal or polygonal or circular or oval cross-section, the channels of the plates being correspondingly adapted to the respective pipe cross-section. The pipes can be flexible or inflexible.

Pipes with a square or rectangular or trapezoidal cross-section can easily be shaped from metal, e.g. by folding sheet metal. In addition, ready-made profiles with U, V, box-shaped and similar cross-section shapes can also be used to make the pipes or the whole pipe system. The circular pipes can be produced from hoses, tubes and the like, which are also available on the market as finished products. Flexible pipes have the advantage that they can adapt to the channels allocated to them. This applies both to the course of the pipes and to their cross-section form. If the contact between the pipes and the plates is to be increased, the effect of a corresponding filling of same is that they essentially lie against the plates with no remaining air gap. The heat absorption thereby becomes clearly better. In the case of pipes inflexible per se, such as e.g. of metal, flexible flanks can be provided in order to carry out a similar adaptation. These flanks can for example be Z-shaped.

In another advantageous development of the invention two or more cover or supporting plates are developed in one piece with each other and form a plate-like element in each case.

By combining several plates to produce a single-piece plate-shaped element, there is the possibility of even simpler production and laying.

A further simplification results in the case of the invention if the pipe system and the supporting plates are developed in one piece with each other.

The possibility presents itself to produce the pipe system merged with the supporting plates because of the heat transfer from metal, e.g. from sheet steel. The heat

absorption from below is thereby considerably increased, as practically no heat passes through to the supporting plates otherwise present in their own layer.

As, with this design, there is no support by separate supporting plates, the unit comprising the supporting plates and pipe system is to be designed such that it still has the necessary stability. Just as in the version where the pipe system is separate from the supporting plates, in the present case there is the possibility of forming each individual element *per se* such that the necessary stability, strength for walking on etc. is guaranteed. In the present case this means either that the cover plates can be developed such that they alone guarantee walk-on strength, or that the pipe system merged with the supporting plates can perform this task. Naturally, a division of tasks between the pipe system and the cover plates is also conceivable.

Through the merging of the supporting plates with the pipe system to produce one unit, the overall structural height of this unit and of the cover plates practically corresponds to the structural height of a normal roof-covering element. This means that, in the area of the device according to the invention on the roof, recesses in the rafters may be absent or there is no need to raise the remaining normal elements relative to the roof part equipped with the device by means of spacers. Consequently, in the case of a subsequent installation of the device according to the invention in an already existing roof, the roof battens as hitherto arranged for the normal elements found there can be used.

A particularly simple design results with the invention if the pipe system has a level supporting sheet to which the pipes are fitted, preferably by welding, in the form of profiled sheets.

The supporting sheet is level and the profiled sheets are fitted to it. In each case, with strip sections of the supporting sheet they form the pipes. The sections of the supporting sheet between the pipes represent the connecting elements. Naturally it is also possible to arrange a ribbed sheet on the supporting sheet in the manner of a sheet pile wall, and to join it to the latter along the common points of contact e.g. by welding. The ribs together with the corresponding sections of the supporting sheet then form the pipes. The ribbed sheet can e.g. be produced by repeated folding of a

normal sheet, the ribs for their part being able to have the already-mentioned cross-section forms, thus e.g. rectangular, square, trapezoidal, polygonal, circular.

If the pipe system is to be still further reinforced, reinforcing ribs can be provided on the underside of the supporting sheet, which should then run chiefly in the direction of the rafters. The reinforcing ribs do not impede the flow of condensation water and increase the stability of the unit consisting of the pipe system and the supporting plates. They increase the absorption surface.

Embodiments of the invention are described below with reference to a drawing. There are shown in:

Figure 1a, b	a cross-section through a device according to the invention in the direction of the roof battens along the line I-I from Figure 2,
Figure 2	a longitudinal section through a device in the direction of the roof battens along the line II-II from Figure 1,
Figure 3	an isometric representation of four supporting plates laid with each other,
Figure 4	an isometric representation of two types of pipe arrays,
Figure 5	a side view of supporting plates stacked horizontally one above the other,
Figure 6	an isometric representation of a pipe array,
Figure 7	an isometric representation of a further version of supporting plates,
Figure 8	a further version of a pipe array,
Figure 9	a perspective representation of a holding device and of a longitudinal track arranged on it,

Figure 10 a perspective view of this track,

Figure 11 a perspective view of the holding device of Figure 9, and

Figure 12 a longitudinal section in the direction of the rafters through a further version (crown tile) of the device, along the line XII-XII of Figure 13,

Figure 13 a cross-section through the version shown in Figure 12 (crown tile) along the line XIII-XIII from Figure 12,

Figure 14 a top view of a cover plate of the version (crown tile) of Figure 12,

Figure 15 a view from below of the cover plate of Figure 14,

Figure 16 a top view of a supporting plate of the version (crown tile) of Figure 12,

Figure 17 a view from below of the supporting plate of Figure 16,

Figure 18 a cross-section through a further version (trough gutter tile Z1) of the invention in the direction of the rafters along the line XVIII-XVIII of Figure 20,

Figure 19 a cross-section through a further version (Jura/Reform) of the invention along the line XIX-XIX of Figure 21,

Figure 20 a longitudinal section of the version (trough gutter tile Z1) of Figure 18 along the line XX-XX of Figure 18,

Figure 21 a longitudinal section through the version (Jura/Reform) of Figure 19 along the line XXI-XXI.

Figure 22	a top view of a cover plate of the version (trough gutter tile) of Figure 18,
Figure 23	a top view of a cover plate of the version (Jura/Reform) of Figure 19,
Figure 24	a view from below of the cover plates of the two versions (trough gutter tile, Jura/Reform) of Figures 22 and 23,
Figure 25	a top view of a supporting plate of the two versions (trough gutter tile, Jura/Reform) of Figures 18 and 19,
Figure 26	a view from below of the supporting plate of Figure 25,
Figure 27	a longitudinal section in the direction of the rafters through a further version (plain tile) of the invention,
Figure 28	a top view of the roof of Figure 27 in the direction of the arrow P, one layer of cover plates being removed,
Figure 29	a top view of a further version of a supporting plate which is suitable, *inter alia*, for the versions of Figures 1 to 5 and 12 to 17.
Figure 30 a, b	a longitudinal section in the direction of the rafters through a further version of the invention with a pipe system developed as an array,
Figure 31 a, b	a longitudinal section through a further version of the invention, in which the pipe system is developed in one piece with the supporting plates, and
Figure 32 a, b	a longitudinal section through a version similar to Figure 31, in which the pipe system extends further into the overlapping area of the cover plates and there is another arrangement of the storm clamps.

Figures 1a, 1b and 2 give an overall view of a device 1 for generating heating from environmental energy. It is integrated into a roof 2 which comprises normal roof-

covering elements 19 customary in the trade. These usually have side rabbeting 33 at their left-hand edge, head rabbeting at the head-side edge of the topside, top rabbeting 34 at the right-hand side edge on the underside and foot rabbeting at the foot-side edge on the underside. The normal roof-covering elements shown constitute a flat interlocking tile. The middle field M is structured longitudinally from the head-side to the foot-side edge.

The normal roof-covering elements 19 are laid on roof battens 531 and are held on these by means of suspension lugs. The roof battens are supported by roof rafters 521 which are arranged in the usual way transversely to the roof battens.

The device has an upper layer 11 of cover plates 12 which essentially have the same head, side, top and foot rabbeting as the normal roof-covering elements 19 and can be used for tiling with the latter without problems. The topside of the cover plates, visible to an observer, is also designed in exactly the same way as the topside of the normal roof-covering elements 19. The cover plates can therefore be laid without difficulty with the adjacent normal roof-covering elements 19.

The device 1 has a lower layer 21 which is formed from supporting plates 22 and special elements 24. The special elements in each case form the right-hand connecting edge of a roof part equipped with the device 1 according to the invention to the other roof part equipped with normal roof-covering elements 19.

The supporting plates 22 and the special elements 24 of the lower layer 21 lie on roof battens 532 which lie lower by a measurement a than the roof battens 531 on which the normal roof-covering elements 19 rest. The roof battens for the device 1 can be sunk by arranging them in a notch cut in the rafter, or by feeding under of the roof battens 531 carrying the normal roof-covering elements 19 e.g. by means of spacers.

A pipe system 41 for a fluid absorbing the environmental energy is fitted between the upper layer 11 and the lower layer 21. In the embodiment of Figures 1 and 2 the pipe system comprises metal tubes 411 running parallel to each other in the direction of the roof battens. The tubes run side by side at a distance which corresponds approximately to the tube diameter. They are laid overlapping elements, i.e. they

extend longitudinally over more than one cover plate, in the case shown they are connected at both their ends to collecting pipes 44 which run essentially in the direction of the rafters. One of the collecting pipes serves as a feed, while the other functions as a discharge.
In the case of hipped roofs and similarly designed roof forms the collecting pipes can also be laid diagonally to the rafters, e.g. following the hips. If the existing length of the pipes 411 between the collecting pipes is insufficient for an adequate energy yield, the pipes can be led in several loops over the roof and then open out into collecting pipes. The collecting pipes can also be arranged side by side at one edge of the roof part covered by the device.

The collecting pipes 44 are connected in known manner to the heating system of a house.

The cover plates 12 have on their underside, and the supporting plates on their topside, channels 1221 and 2211 respectively, in each case running in the direction of the roof battens, and serving to house the pipes 411 of the pipe system. The channels are guided kink-free over their whole length and run, in the laid state, at the same level over their whole length, so that the channels of adjacent plates are flush with each other and open continuously into each other. In the laid state, the channels of the supporting and cover plates are matched so that, with each other, they form a common, continuous cavity for the pipes 411 of the pipe system.

In the present case the channels are in the form of gutters with an approximately semi-circular cross-section. Between the gutters the cover plates have ridges 1223 and the supporting plates have ridges 2213. Just like the channels, the ridges, in the laid state, are also arranged one above the other, filling the space between the gutters. Although in the case shown the ridges are approximately as wide as the gutters, in order to increase energy generation in the ridge area it is conceivable to make the ridges wider than the gutters, e.g. in the ratio of 2:1.

The supporting plates 22 have an essentially level middle field 221 which opens out at the same level into the top-rabbet part 224. Figures 1a and 1b show that the side-rabbet part 223 is pushed downwards so far that the top-rabbet part 224 is also

arranged below the surface level of the middle field 221. This means that the plane of the middle field 221 extends unbroken over the top-rabbet part 224.

The side-rabbet part has a side-rabbet groove 2232 which runs essentially straight from a head-rabbet part 225 to a foot-rabbet part 226. It only rises slightly from the foot- rabbet part to the head-rabbet part. In the area of the head-rabbet part it opens out into a bearing surface 2225 which is sunken relative to the middle field, and arranged on this are ribs 2251, running in the direction of the rafters, which are to serve as bearing supports for the respective overlapping supporting plate 22. In the case shown two and three ribs respectively are arranged which are distributed approximately evenly over the width of the bearing surface, so that they prevent rocking of the superjacent supporting plate. The ribs are in addition to drain any condensation water running down the underside of the overlapping supporting plate onto the bearing surface and thus into the side-rabbet groove.

Approximately in the centre of the bearing surface there is a centring head 2256, which is arranged near the eaves-side end of the head-rabbet part. Between it and the middle field there is however still a free space for the drainage of the bearing surface 2255. The centring head has a very much greater width in the direction of the roof battens than depth in the direction of the rafters, i.e. the top view represents a rectangle, the longer side of which runs in the direction of the roof battens.

The centring head 2256 has a recess 2267 allocated to it at the foot-rabbet part 226 of each supporting plate. The recess also has a greater width in the direction of the roof battens than depth in the direction of the rafters. Its dimensions are such that in the tiled state, it encloses the centring head with side clearance. The width of the recess in the direction of the roof battens is consequently somewhat greater than the width of the centring head. The depth in the direction of the rafters is chosen so that in the covered state both the centring head and a suspension lug 1254 of the corresponding, overlapping cover plate 12 can engage in the recess.

This means that the depth of the recess 2267 in the direction of the rafters corresponds at least to the depth of the centring head 2256 plus the depth of the suspension lug 1254 of the cover plate. If a storm clamp is still also to be passed through the recess in

order to anchor the supporting plate to the roof substructure, said recess is to be dimensioned so that, behind the centring head 2256 and the suspension lug 1254 of the cover plate, a free space still remains through which to pass the storm clamp (not shown).

The foot-rabbet part 226 is located approximately at the same level as the bearing surface 2255 of the head rabbet part 225. Both the topside and the underside of same are level. The foot-rabbet part 2226 is connected to the middle field over a relatively short incline. The height of the foot rabbet part 226 is at least the sum of the height of the body thickness in the area of the side-rabbet groove 2232 plus the height of the outer side-rabbet rib.

The top-rabbet part 224 has therefore been pushed below the level of the middle field part 221, in order to be able to allow the latter and the channels 2211 or ridges 2213 arranged there to run through at the same level from the side-rabbet part over the top-rabbet part. The top-rabbet part has a top-rabbet groove 2242 running through from the head-rabbet part to the foot-rabbet part.

On the underside of the supporting plates, reinforcing ribs 2222 run parallel to each other from the head-rabbet part to the beginning of the foot-rabbet part, as these allow on the one hand the horizontal stacking (no concertina-like fanning-out when stacking), walk-on strength, and on the other hand as small a body thickness as possible, which is desirable for reasons of heat conduction. The supporting plates are anchored by means of suspension lugs 2221 on the roof battens 532. At the foot-side end of the top-rabbet part 224 the latter has a corner cut-out 2245 and at the head-side end a smaller corner cut-out 2244.

Figures 1a and 1b, and 2 show that the underside of the cover plates 12 is configured corresponding to the topside of the supporting plates 22. It is not difficult to see that the channels 1221 also extend from the free end of the side-rabbet part 123 to the beginning of the top-rabbet part 124. There also, ridges 1223 are provided between the gutters, to house the pipes 411. These ridges are dimensioned approximately just as wide as the ridges 2213 of the supporting plates. In Figure 3 the upper row of the overlapping supporting plates shows seven gutter-shaped channels for the pipes in

each case, while the underlapped row only has five. While, in the case of the upper row, the ridges are therefore less wide, but there is consequently more room available for the pipes, this is achieved differently in the case of the underlapped row of supporting plates with only five gutters. There a much larger proportion of the available middle field surface is made available to the ridges than to the gutters, as the heat flow occurring over the ridges can be diverted via the connecting sheets 4135 to the tubes 411.

When the shown device 1 is tiled, each supporting plate is allocated its own cover plate 12. It engages in the manner already described with its suspension lug 1254 in the recess 2267 and rests against the centring head 2256. During tiling, it lies with its head-rabbet part 125 on the foot-rabbet part 2226 of the supporting plate arranged ridge-side of it. While the side-rabbet part 123 and top-rabbet part 124 are developed in the case of the cover plate 12 exactly as in the case of the normal roof-covering element 19, the head-rabbet part 125, unlike the normal roof-covering elements 19, is designed level on its underside for the bearing possibility just mentioned, and provided with the special suspension lug 1254 which allows the anchoring in the recess 2267.

In order to be able to combine several pipes, e.g. tubes 411, into a unit, in particular into a tube array 413, connecting elements 4131 are provided which fix the tubes rigidly side by side. These can be pins 4133, fish-plates 4134 or also sheets running over the whole length of the tubes. This in no way exhausts the design possibilities of the connecting elements 4131. The tube array 413 can be prefabricated before laying, e.g. by soldering, welding, gluing or, as in the case of the array shown in Figure 6, by pultrusion or continuous casting. Depending on which material is used, extrusion can also be considered. It can also be produced as piece goods.

The connecting elements can contribute much to the energy absorption of the pipe system and, compared with the surface of the pipes, make available many times the absorption surface. The width of a tube array 413 is generally equal to the width covered by the individual plates.

With regard to the shrinkage which is customary, and not always the same, in the case of ordinary ceramics, the tube array can also be divided as shown in Figure 8. The section 413a is identical to the section 413b and is fitted next to the latter in a plane to a layer of supporting plates. In this case the supporting and cover plates have a total of ten gutters, to house the tubes 411.

Between the two sections 413a and 413b, because the edge sheets 1436 are somewhat shorter than the sheets 4135 situated between the tubes 411, there is a gap 4137 which serves to compensate for any shrinkages in the plates. Provided an asymmetrical structure of the sections 413a and 413b does not cause problems, the outer sheets 4136 shown in Figure 8 can be wider than those forming the gap between them.

In the case shown, both the sheets 4135, 4136 and the tubes 411 have a wall thickness of approximately 2 mm. The tube array 413 is made from Alu.

In order to create the necessary free space for the connecting elements 4131, there are cut-outs 2217 in the ridges 1223 of the cover plates and/or the ridges 2213, which can be adapted to the shape of the connecting elements. Figure 3, in the case of the overlapping layer of supporting plates 22, shows the cut-outs 2217 as depressions in the ridges. The tube array 413 shown in Figure 4 fits into the shown overlapping layer of Figure 3, as the connecting pins 4133 can engage in the cut-outs 2217 in the upper left supporting plate, while the connecting fish-plates 4134 fit into the cut-outs 2217 of the rear overlapping support plate.

The ridges 2213 of the underlapping supporting plates 22 of Figure 3 are developed lower overall, so that e.g. a tube array of Figure 6 could be arranged on these plates.

By dimensioning the height of the ridges of both the supporting and cover plates in relation to the heights of the cavities formed by the channels 2211 and 1221 it can be determined how and where the cover plates 12 rest at the pipe system or on the supporting plates 22. A close contact between the ridges of the supporting and cover plates on the one hand and the connecting elements, in particular connecting sheets 4135, is welcome, as these parts are very suitable for the transmission of energy from the cover plates to the supporting plates and because of the direct contact also allow a

good heat conduction from the plates to the pipe system. It is to be borne in mind that both the heat conduction from the supporting plates to the pipe system, and from the cover plates to the pipe system is beneficial and can be utilized to generate heat.

Figure 7 shows a supporting plate which generally corresponds to the supporting plates of Figure 3, but in which the tube array of Figure 8 with its sections 413a and 413b can be housed. Unlike the supporting plates of Figure 3, the top-rabbet part 224 is developed without corner cut-outs in the head- and foot-rabbet parts, and very much smaller overall. The underside of the foot-rabbet part 226 is arched in the area of the recess 2267, in order to divert any condensation water occurring to the side- or cover-rabbet part.

A further difference is that a head-rabbet groove 2252 extends between the centring head 2256 and the middle field 221 over the whole width of the plate, inclined slightly towards the side-rabbet part 223 and draining into the side-rabbet groove 2232. The ribs 2251 are pushed down right at the edge of the bearing surface 2255, the rib arranged in the top-rabbet area running in the direction of the rafters as in the other version, but enclosing the corner cut-out 2244 in the head area in an L-shape.

The moulded piece 24 was already mentioned at the start. This serves to form the right-hand edge of a roof surface laid with supporting plates 22 and corresponds with one exception to the supporting plates 22 already described. The moulded piece 24 lacks a small part of the middle field and in particular of the top-rabbet part 224. It results from a cut in the direction of the rafters along the line b-b over the whole length of the plate.

The cut can be made either when the plate is finished, or during production, e.g. after pressing.

The moulded part 24 allows the attachment of the collecting pipe 44 between the trim line b-b and the side-rabbet part 33 of the adjacent normal element 19. The trim line lies slightly to the right of the right-hand reinforcing rib 2222.

In order to be able to better utilize the heat flow from below to the supporting plates, which is important for the transmission of heat to the pipe system, according to a development of the invention it is provided to replace the roof battens 532 in the area of the device 1 by tracks 533 which are attached to the roof substructure, e.g. to the rafters 521 by means of spacers 522.

The spacers in the present case comprise U-shaped profiled sections, the U-opening of which is open in the direction of the eaves. A lower U-leg lies against the roof sub-structure, while the topside serves to attach the track 533. The connecting leg produces the distance between the track 533 and the substructure of the roof. The track runs in the direction of the roof battens and serves, like the roof battens, to house and anchor the respective suspension lugs.

The track can be fixed onto the spacers with usual fixing means, e.g. screws. In order to be able to carry out a longitudinal compensation, i.e. in order to be able to compensate for differences in the length covered, the upper U-leg of the spacers can be provided with a longitudinal hole 5223 in the direction of the rafters. Likewise, the sheet track 533 can be provided in its eaves-side area with longitudinal holes transversely to the direction of the rafters. The track is then to be fixed at the intersection of their longitudinal holes 534 onto the spacers and their longitudinal hole 5223. The purpose of the longitudinal holes is to be able to more easily align the joints of the track to each other. The longitudinal holes are positioned in the eaves area of the track in order to ensure that the track, even if it is fully shifted in the direction of the eaves, still projects ridge-side slightly over the spacers 522, in order to avoid the suspension lug being directly suspended against the spacer under any circumstances.

The arrangement of the holding devices for the plates, i.e. the use of the spacers and tracks provided in the present case, results in the creation of a largely free space for air circulation below the supporting plates 22. The air present under the supporting plates can essentially flow the whole length along the back of the supporting plates and is scarcely obstructed at all in its movement.

This results in a much improved heat transfer from the air to the supporting plates. In order to still further reduce the obstruction of the rearward airflow, the suspension lugs 2221 of the supporting plates 22 can be kept as narrow and low as possible. A hole 5224, for inserting a storm clamp (not shown), can be present in the connection leg of the spacer 522.

The pipe system according to the invention can be formed from vessels of all kinds. Although the cut-outs in the case shown are tailored to pipes with a circular cross-section, pipe vessels with other geometric e.g. rectangular cross-section shapes are also possible. It may in particular be stressed that containers with feed and discharge pipes for the pipe system can also be used. In this case it is also possible to provide several, instead of one, fluid chamber in the container. In addition to the metal tubes already mentioned, vessels of other kinds, e.g. tubes, hoses, compartment foils etc. can also be considered as pipes.

Figure 5 shows that the supporting plates 22 can also be stacked horizontally. The reinforcing ribs 2222 in each case rest on the middle field of the supporting plate situated underneath, and permit the said horizontal stackability. This means that, when plates are stacked one on top of the other, the resulting stack does not fan out concertina-fashion. The cover plates are also capable of being stacked horizontally in a manner not shown.

Moreover, it may be stressed that in the production of the covering and supporting plates the same drying frame can be used in each case as in the production of the normal elements.

When installing the device according to the invention, the roof battens provided for the device itself must first be laid lower by a measurement a than the roof battens for the normal roof-covering elements. This can be achieved either by a notch cut in the rafters or by feeding under of the roof battens for the normal roof-covering elements. During installation of the battens, care must be taken to ensure the correct distance between the roof battens and the flush alignment of adjacent roof battens. It is thereby to be ensured that the channels of the covering and supporting plates are also flush with each other.

If the roof battens are to be replaced by holding devices, such as profiled sections 522 or tracks 533, the latter must be fitted on the roof sub-structure in place of the roof battens with the same care.

The supporting plates can then be laid on the roof battens, or holding devices respectively, in the form of a lower layer 21. They are imbricated, i.e. the supporting plates are placed on the roof substructure proceeding from the bottom upwards. The foot-rabbet parts of the overlapping supporting plates in each case rest on the bearing surface 2225 of the head-rabbet part 225 of the underlapped supporting plates. In the case shown the supporting plates are laid in a row, i.e. they lie one behind the other in the direction of the rafters, and the side-rabbet grooves in each case drain into each other.

A composite installation is also possible, provided the supporting plates are modified slightly. In this case it would be necessary to arrange the recess 2267 and the centring head 2256 eccentrically.

Composite installation has the advantage that the side-rabbet part drains directly onto the head-rabbet part of the underlapping supporting plate. In addition, in connection with the structural height of the foot-rabbet part, there is also the possibility of draining the side-rabbet part onto the roof surface.

The pipes 411 are then fitted to the laid supporting plates 22. This takes place either by laying the individual pipes in the direction of the roof battens, on the gutters of the supporting plates which are flush with each other, or by fitting the pipes in the form of pipe arrays 413 or 413a and 413b. The pipes can be dimensioned such that they span in one piece the whole roof surface provided for energy generation. However, they can also consist of several parts to be joined in series.

Because the gutters run flush with each other in the direction of the roof battens, it is necessary to adapt the pipe system. It is sufficient simply to lay the pipes in the gutters.

The cover plates 12 can then be laid on. In the case shown each supporting plate is allocated a cover plate 12 arranged essentially above it. It engages with its suspension lug 1254 in the free space available inside the recess 2267 and rests on the centring head 1256. This is clearly shown by Figure 2.

Through the introduction of the suspension lug 1254 into the recess 2267, each cover plate independently centres on the supporting plate allocated to it. This means that the channels on the underside of the cover plates appear above the corresponding cut-outs on the topside of the supporting plates and together form the cavity for the pipes 411. The pipe system also anchors the cover plates to the supporting plates in form-locking manner.

In order to perfect the system it is still necessary to connect the pipes to collecting pipes 44. Depending on the length of the pipes this can be done simply by connecting each free end of the pipe to a collecting pipe feeding and discharging the fluid. However, it may also be necessary in each case to connect several pipes running in the direction of the roof battens meander-like to each other, and only after this series connection of several pipes connect them in each case to collecting lines, which can then optionally also be led on the same side of the device in the direction of the rafters or hip.

Figures 12 to 28 show versions of the invention in which in each case the supporting plates 22 in the roofing do not rest with their foot parts 226 on the head parts 225 of the supporting plates 22 following on the eaves side, but of the cover plates 12 following on the eaves side. This results in a roof in which the supporting and cover plates form a continuous layer in each case along a contour line. During laying, care must be taken that the layers of covering and supporting plates sharing the same contour line that lie one on above the other must be completely laid before the laying of the next- higher layer of supporting plates is started. Naturally, before fitting the layer of cover plates, the pipe system is first to be fitted on the layer of the supporting plates.

The versions of Figures 12 to 28 will be explained in detail only where they differ from the previous versions. Otherwise, the above statements are to be transferred as

appropriate to the following statements. Corresponding parts are given the same reference numbers.

The technical term for the normal roof-covering elements of the version in Figures 12 to 28 is "crown tile". The name refers to the crown-like step at the base of the tile. This step leads to a high structure at the base. In spite of this shoulder, it is possible to also provide covering and supporting plates for this type of tile which permits a seamless insertion for a roof area covered with normal crown tiles. This is particularly important in the case of listed buildings, the roofs of which are laid with crown tiles.

Figure 12 shows that this has been achieved by having the overall level of the laid supporting plates set much higher in a vertical direction than is the case in the versions described above. The crown tile has double side-rabbeting 223 and is also very suitable for flat roofing because of the good drainage possibilities in the side rabbet area.

The cover plate 12 shown in Figure 14, like every crown tile, possesses a head-rabbet part 125 with single rabbeting. The underside shown in Figure 15 of the cover plate 12 has, as a noteworthy detail, a suspension lug 1254 running almost over the whole width of the tile, separated from the middle field by an equally long groove 1256. Figure 12 shows that during tiling the cover plate 12 covers the associated supporting plate 22 over the whole depth in the direction of the rafters. The suspension lug 1254 encompasses a corresponding centring head 2256 in the head area 225, which engages in the groove 1256.

In the foot area the cover plate 12 projects over the foot end of the overlapped supporting plate 22 and encompasses with a foot rib 1261 a head-rabbet rib 12511, continuous in the direction of the roof battens, of the cover plate overlapped on the eaves side, which extends almost over the whole width of the tile in the direction of the roof battens.

The crown tile or the covering and supporting plates of this version are constructed such that the cover plates can be laid both in a row and also in a composite structure in relation to the supporting plates. This is clear in particular from Figure 13.

The supporting plate 22 shown in Figure 29 has, in the foot-rabbet part 226, a recess 2267 which connects directly to the incline leading to the middle field, keeping the foot-rabbet part 226 very short and thereby correspondingly extending the foot end of the middle field. The available absorber surface is thus enlarged.

Figures 30 a, b; 31 a, b; and 32 a, b show further versions to which the above applies accordingly. Identical or corresponding parts are given the same reference numbers. Hereafter only the differences from the versions already described will be discussed.

In Figure 30 a, b a longitudinal section running in the direction of the rafters is shown by a version in the manner of a flat interlocking tile. The pipe system 41 in the present case has a supporting sheet 4138 to which the pipes 411 are fitted in the form of ribs running through in the direction of the roof battens. The supporting sheet, just like the ribs, consists of sheet steel. The ribs have a trapezoidal cross-section, the base of the cut trapezium facing the supporting sheet. The pipes are welded onto the supporting sheet, watertight over their entire length. The sections, located between them, of the supporting sheet form the connecting elements 4131 between the pipes.

In this version the pipes are therefore formed on the one hand by the welded-on, trapezoidal hollow ribs, and on the other hand by the sections of the supporting metal plate overlapped by these ribs.

When manufacturing the pipe system, the ribs can be fitted individually to the supporting sheet. Commercial profiles customary in the trade can for example be used, e.g. U-shaped, V-shaped or with an open or closed box section. It is also conceivable to form several ribs, side by side, into a continuous sheet, e.g. by folding, and then position this ribbed sheet opposite the supporting sheet and join it to the latter.

In the case shown, the supporting sheet is arranged under the pipes and rests on an essentially level surface of the supporting plates. In the direction of the roof battens, it spans several supporting plates situated side by side. In the direction of the rafters it extends from the head part of the overlapped supporting plates to their foot part, and may even project beyond the latter.

In the present case the channels 1221 are therefore exclusively contained in the cover plates. They are six in number. All have a trapezoidal cross-section, the design of which is adapted to the pipe in question. Between the channels the ridges 122 can be seen, with which the cover plates rest on the supporting sheet 4138. In order to ensure a defined support of the ridges on the supporting sheet, the channels are dimensioned such that an air gap remains between them and the pipes 4111. The trapezoidal cross-section of the channels comes in useful when manufacturing the cover plates, as it does not impede the demoulding process of the latter when pressing from clay. In addition the trapezoidal shape increases the stability of the cover plates. In the version shown in Figure 30 a, b the body thickness of the supporting plates 22 can be kept small compared with the other versions, as the static functions can be performed by the cover plates and the pipe system. The requirement for the supporting plates to be safe to walk on and display static strength is satisfied by the possibility of making the ridges 1223 present between the pipes as high or as thick as the overall body thickness less remaining residual body thickness.

The small body thickness of the supporting plates 22 permits a much better exploitation of the heat absorption from the back of the system or from below. Reducing the body thickness of the supporting plates can at the same time result in the intrinsic inclination of the plates, i.e. the angle between the rafters and the battens, being reduced. In addition, the structural height can be kept smaller, so that the recesses necessary in the area of the device according to the invention can be made smaller to compensate for the difference in height between the normal roof and the energy roof, or conversely the feeding under of the normal roof can be kept smaller in the case of rafters in which no notches have been cut.

In the case shown the trapezoidal pipes have a much larger cross-section than e.g. the pipes of the embodiment of Figure 2, formed as round tubes. In the version of Figure 30 a, b, the pumping capacity of the circulating pump can consequently be reduced.

Because of the enlarged cross-section of the trapezoidal pipes, it is also sufficient to provide a smaller number of pipes.

There are only six pipes. Because of the increased cross-section per pipe, it is also unnecessary to pass fluid through each pipe. It would e.g. also be sufficient, in the case of the version of Figure 30 a, b, to pass fluid only through every second tube. This reduces the fluid requirement, the weight of the whole system and the number of necessary pipe connections. In Figure 30 a, b the pipes actually filled with a fluid have the reference number 4111. The remaining pipes are hollow and mostly sealed air-tight at their ends. The hollow pipes do however contribute to the heat generation. They absorb the heat and convey it to the fluid-filled pipes. These pipes can also be charged on the counter-current principle.

In the version shown in Figure 31 a, b the supporting plates 22 are merged into one unit with the pipe system 41. The pipe system is essentially constructed exactly as in the version of Figure 30 a, b, except that the number of pipes has fallen to four. Again, only half the pipes, namely those with the reference numbers 4111, are fed with the cooling fluid. The remaining pipes remain empty. It is clearly shown, how the cover plates rest with their ridges 1223 on the supporting sheet 4138. The pipe system 41 merged with the supporting plates lies on the one hand on the roof battens 531, on the other hand on the head part 125 of the underlapping cover plate 12. In this version the overall structural height of supporting plate, pipe system and cover plate corresponds to the structural height of a normal roof-covering element, i.e. there are no recesses in the rafters in the energy-roof area or raising of the normal roof. In this version, where the energy roof is installed later, the existing roof battens can be reused without needing to be modified, e.g. lowered.

As the supporting plates merge with the pipe system, the supporting plates also no longer offer resistance to the passage of heat, which means that the heat absorption from below can be clearly increased.

The longitudinal section of Figure 31 a, b also shows the use of normal storm clamps. In order to be able to insert these storm clamps it is necessary to provide recesses in the supporting sheet 4138.

The dimensioning of the reinforcing ribs 1223 between the pipes 411 is chosen such that the cover plates as such are safe to walk on and stable. The width of the recesses

in the direction of the rafters is dimensioned such that, during the production of the cover plates, there would be no reason to fear subsidences in the area of the channels at this stage.

In order to drain condensation water from the back of the pipe system 41, it is also possible to provide bearing ribs 1257 in the head part 125 of each cover plate 12, which allow the diversion of the water to the topside of the cover plates and its drainage through the head-rabbet part and the side-rabbet part. Figure 31b shows the longitudinal section without storm clamps. This clearly shows the stacking humps 1256 necessary for the horizontal stackability of the cover plates. With regard to the production of the cover plates, the height of the ribs 1223 is dimensioned such that when drying they rest without difficulty on the drying support, e.g. the drying frame.

With respect to statics and thermal balance, there are in principle two possibilities for the height dimensioning of the pipes, as well as the channels 1221 and the ribs 1223. With the first possibility the ribs lie directly on the supporting metal plate 4138. This results in an air gap 4931 between the channels 1221 and the pipes 411. The air gap 4933 present in the area of the ridges disappears because the ridges practically rest on the supporting sheet and can be left out of consideration.

With the second possibility the air gap 4931 between the channels and the pipes 411 will be minimized, i.e. the cover plates rest directly with the channels on the trapezoidal pipes 411. As however, e.g. when manufacturing the cover plates 12 from clay, their dimensional accuracy and shape conformity can never be guaranteed as in the case of other materials, in this case the air gap 4933 becomes larger. The second possibility is more favourable from the point of view of heat engineering, as the direct contact surface between cover plate and pipe system is much larger than with the first possibility.

Figure 32 a, b shows a further version which is essentially the same as that of Figure 31 a, b. The pipe system 41 is, however, drawn further in the direction of the eaves. The heat absorption in the overlapping area of the cover plates is therefore improved. In the case of the present version the head-edge strip of the cover plates is developed

deeper. Thus the possibility of Figure 31 of arranging the stacking humps 1256 no longer obtains.

When considering horizontal stackability, only the stacking points in the head-rabbet area are involved. For this reason, only these are represented, but all the other stacking points in the area of the foot-side-rabbet angle and the head-top-rabbet angle are retained.

In the case of the version of Figure 32 a, b the outer head-rabbet rib 1251 serves as a stacking hump. It is necessary to raise this rib correspondingly. The height of the surface of the head-rabbet rib as far as the underside of the cover plate has the same body thickness as the height of the stacking hump 1256 of Figure 31 a, b as far as the lower edge of the suspension lug 1254. Due to the raising of the rib 1251, necessary for horizontal stackability, in the version of Figure 32 a, b a groove 1262 results at the foot-rabbet area, in which the head-rabbet rib 1251 engages.

The storm clamp 59 has at its upper end a hook 593 which engages in a cut-out 594 provided for this purpose in the head-rabbet part 125. The supporting sheet 4138 projects beyond the cut-out 593, so that any condensation water or perspiration water cannot enter the cut-out 594. The head part 125 of the cover plates 12 is also again provided in known manner with ribs 1257, in order to produce a corresponding gap between the supporting sheets 4138 and the head part 125 and to divert condensation or thaw water.

At its rear, the supporting sheet 4138 in the form shown has absorber ribs 41381 on its back, which enlarge the absorber surface at the rear, and thereby promote heat absorption. The ribs preferably run in the direction of the rafters in order not to form any drip points for the thaw or condensation water.

The right-hand pipe in Figure 32 has essentially the same cross-section shape as the other pipes 411. It is however equipped with flexible flanks which allow the pipe to "breathe". This means that the latter can be enlarged upwards in its chamber volume, in order to minimize the air gap 4931.

Number: 30 12 111
Int. Cl.³: F 24 J 3/02
Application date: 28th March 1980
Date laid open for public inspection: 8th October 1981

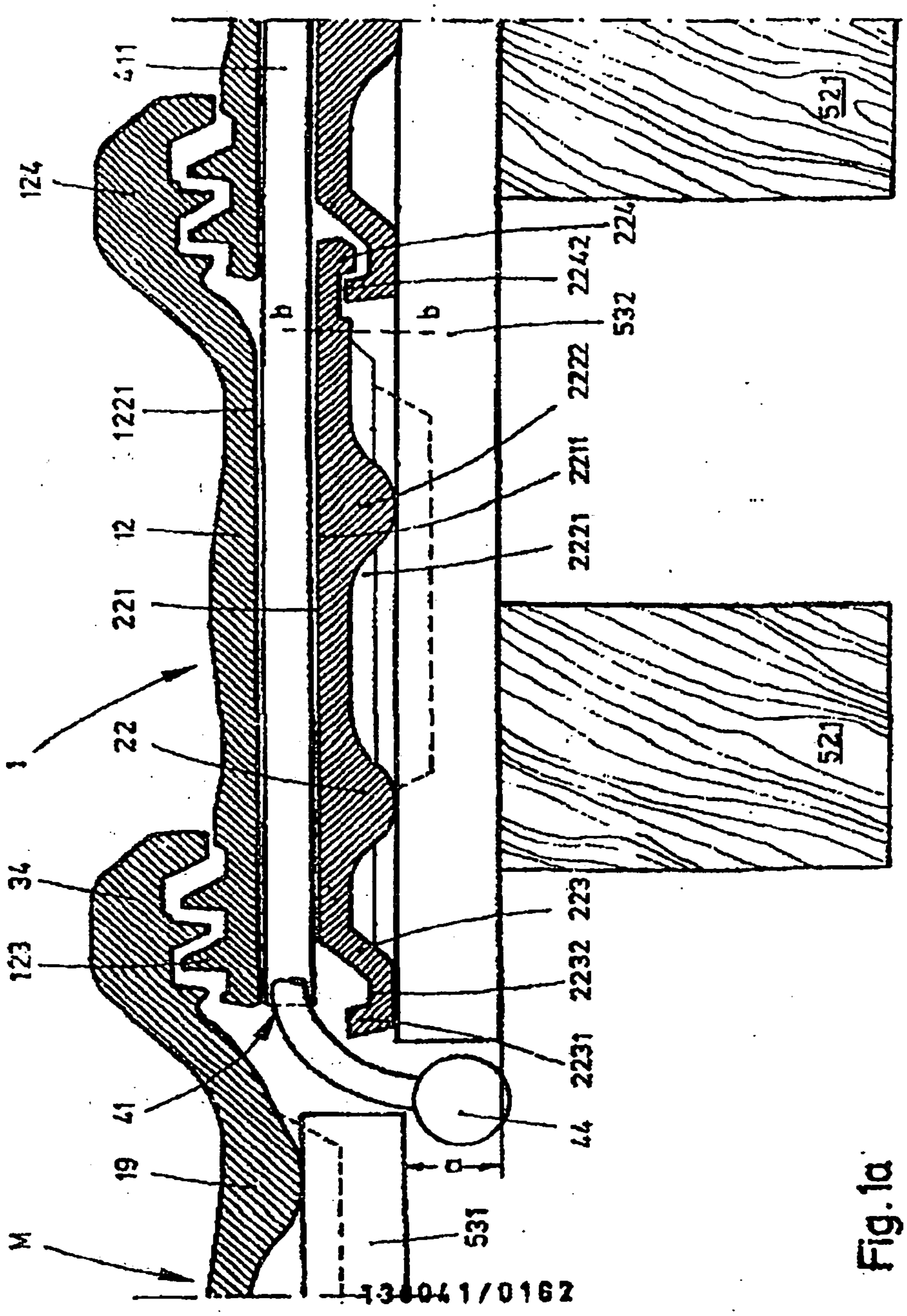

Fig.1a

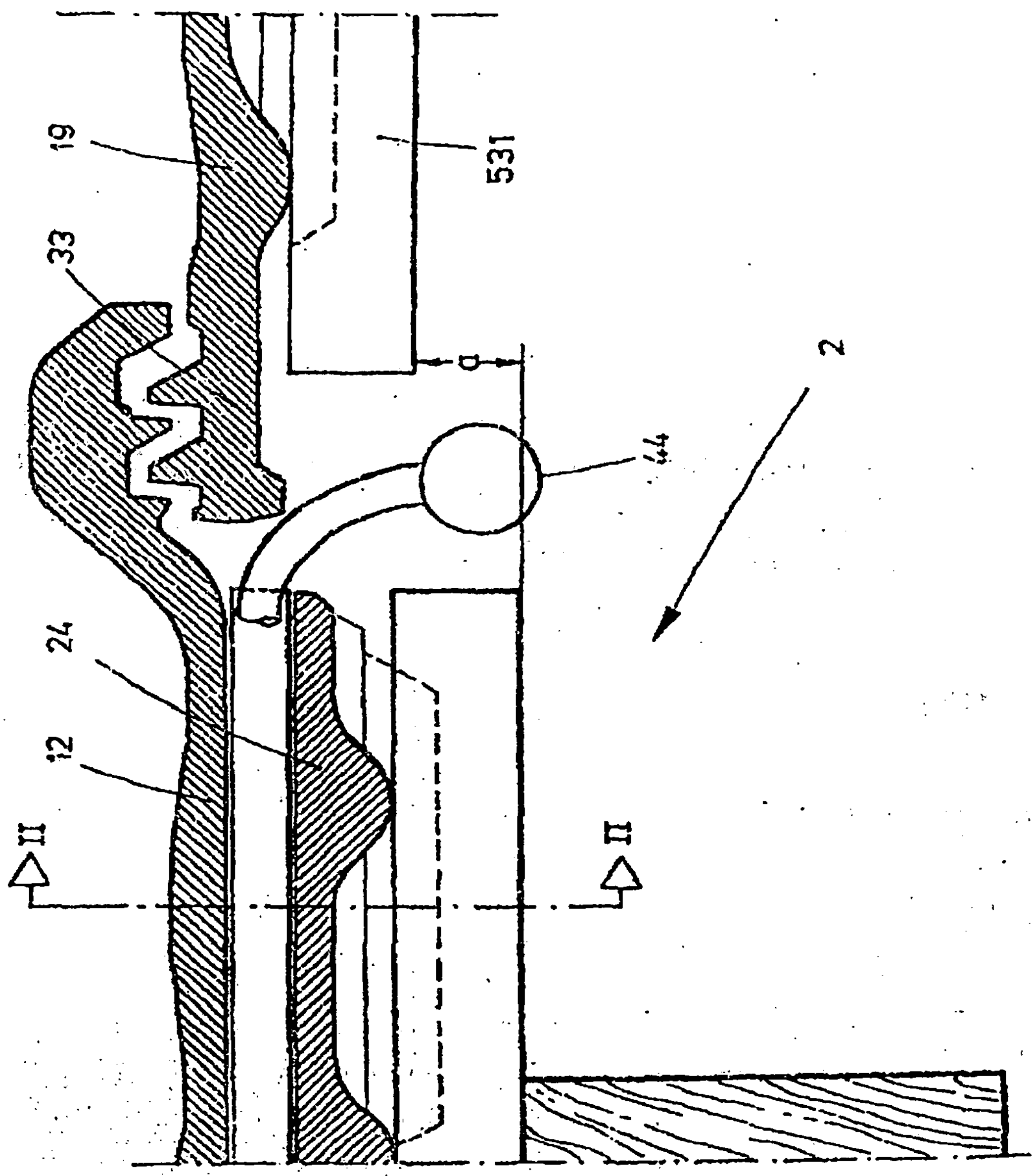

Fig. 1b

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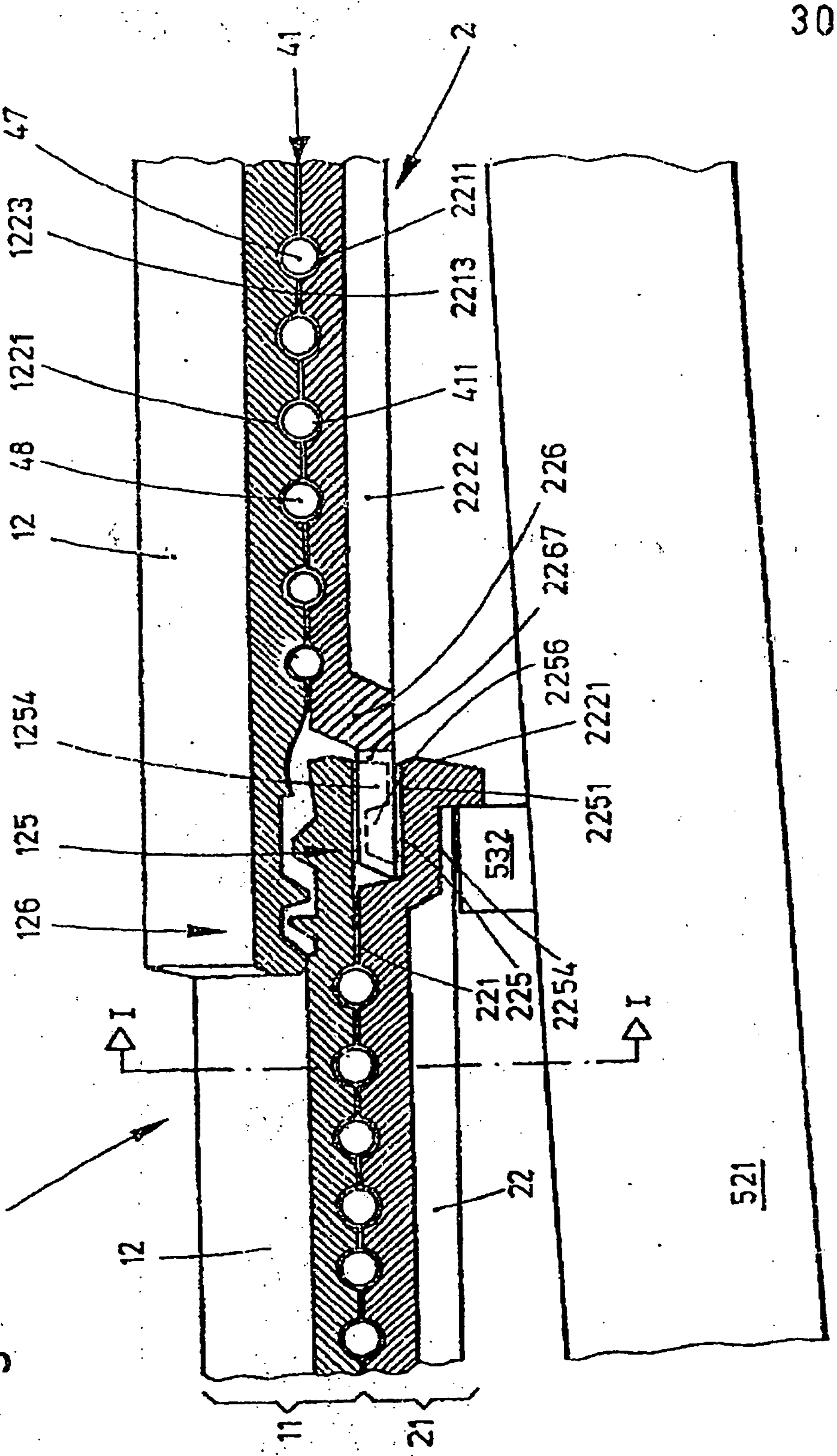
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Fig.2

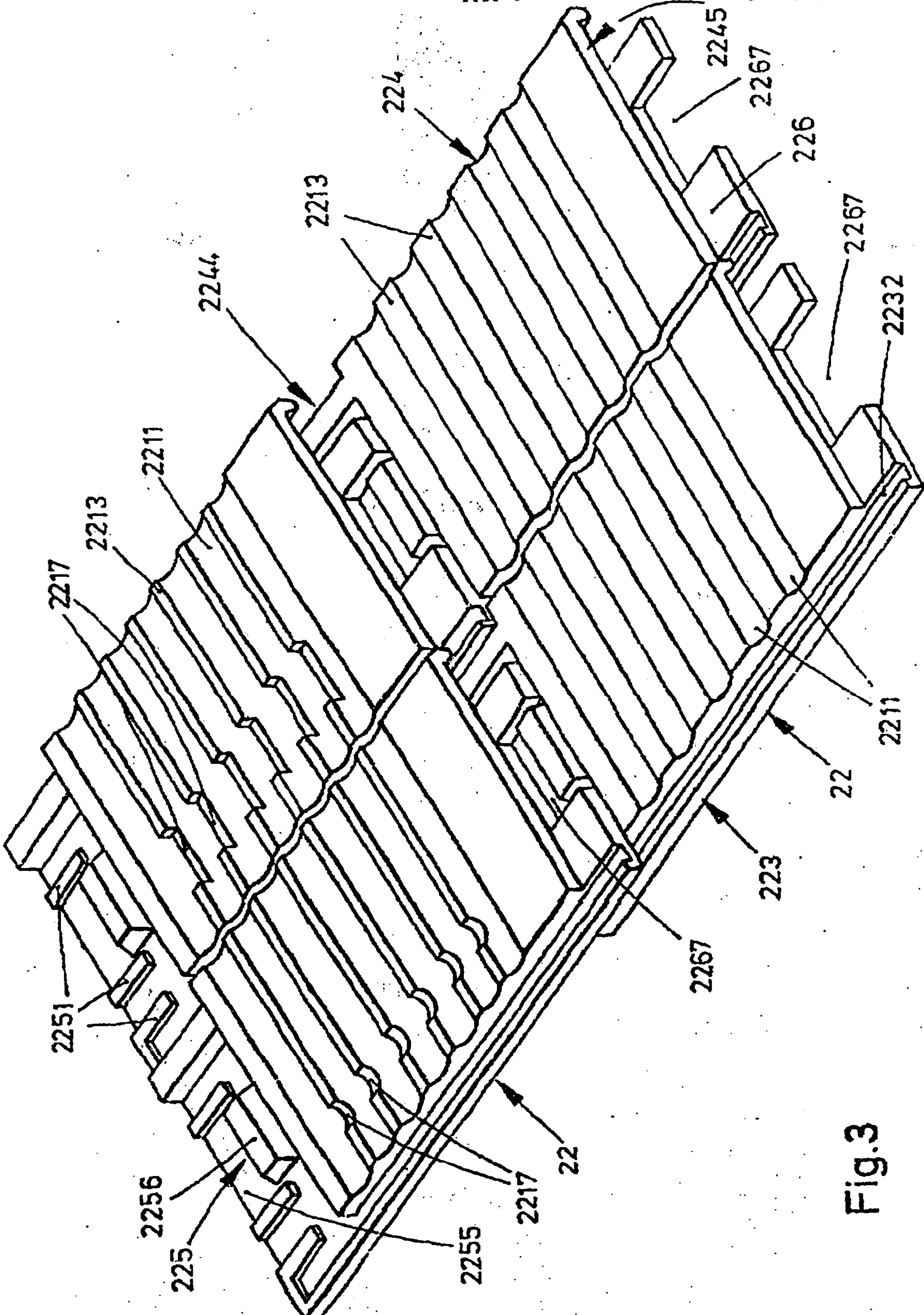
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Fig.3

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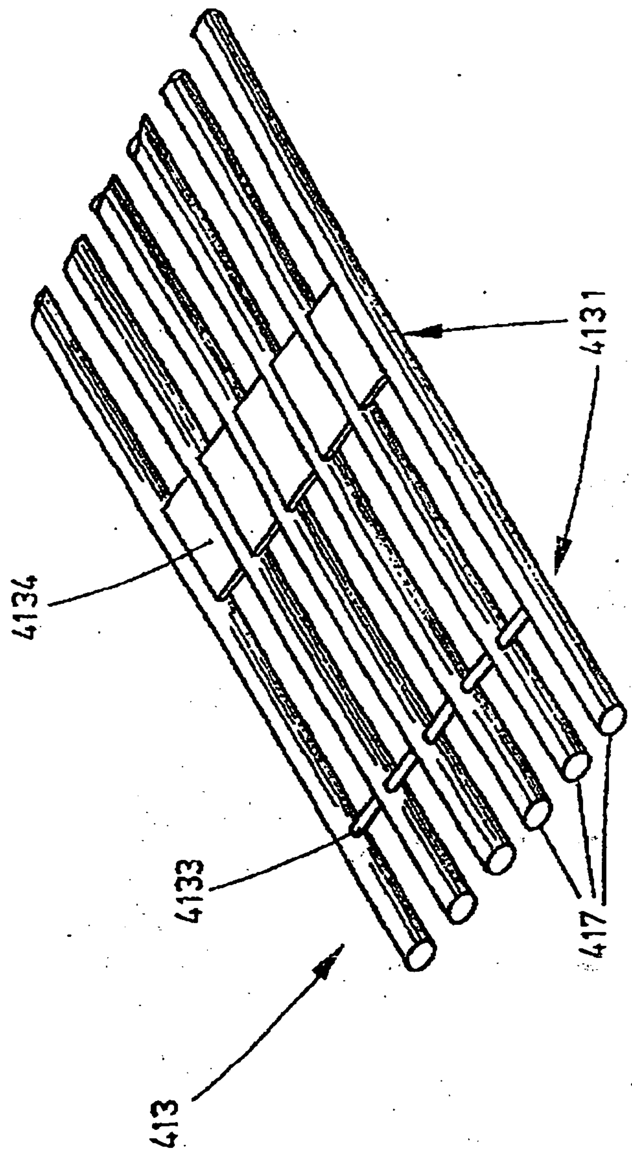

Fig. 4

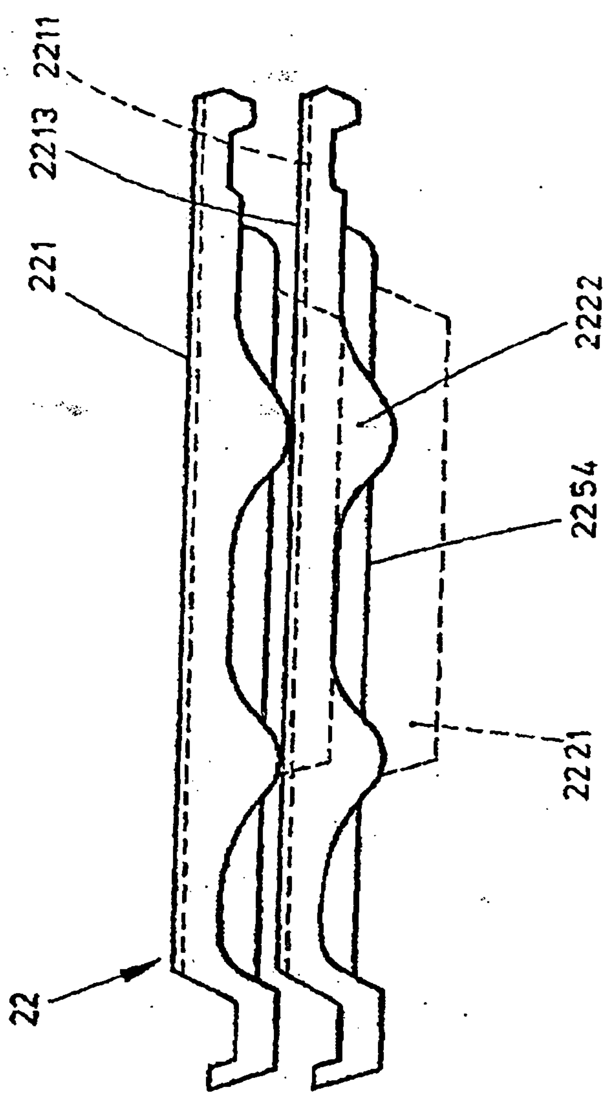

Fig.5

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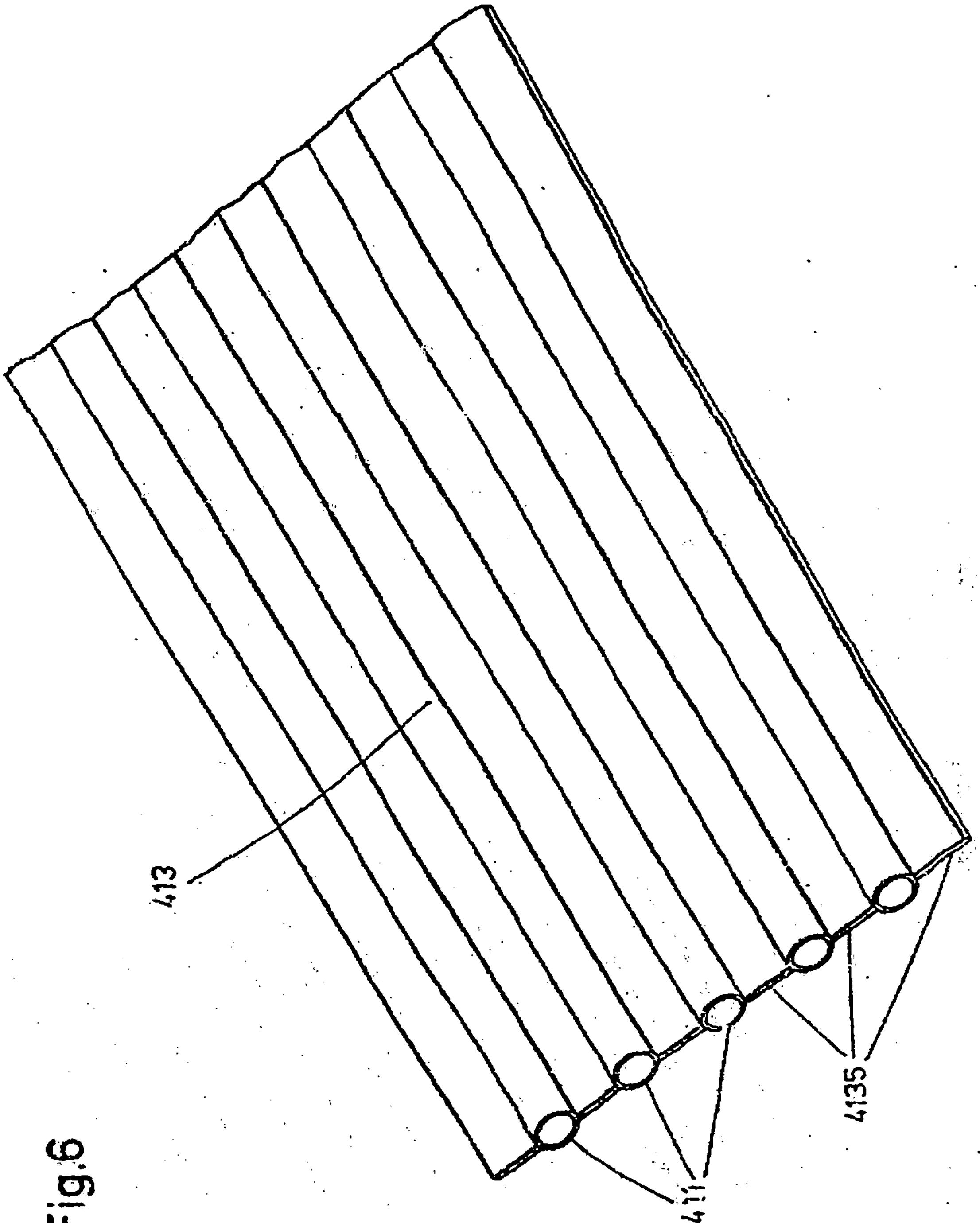

Fig.6

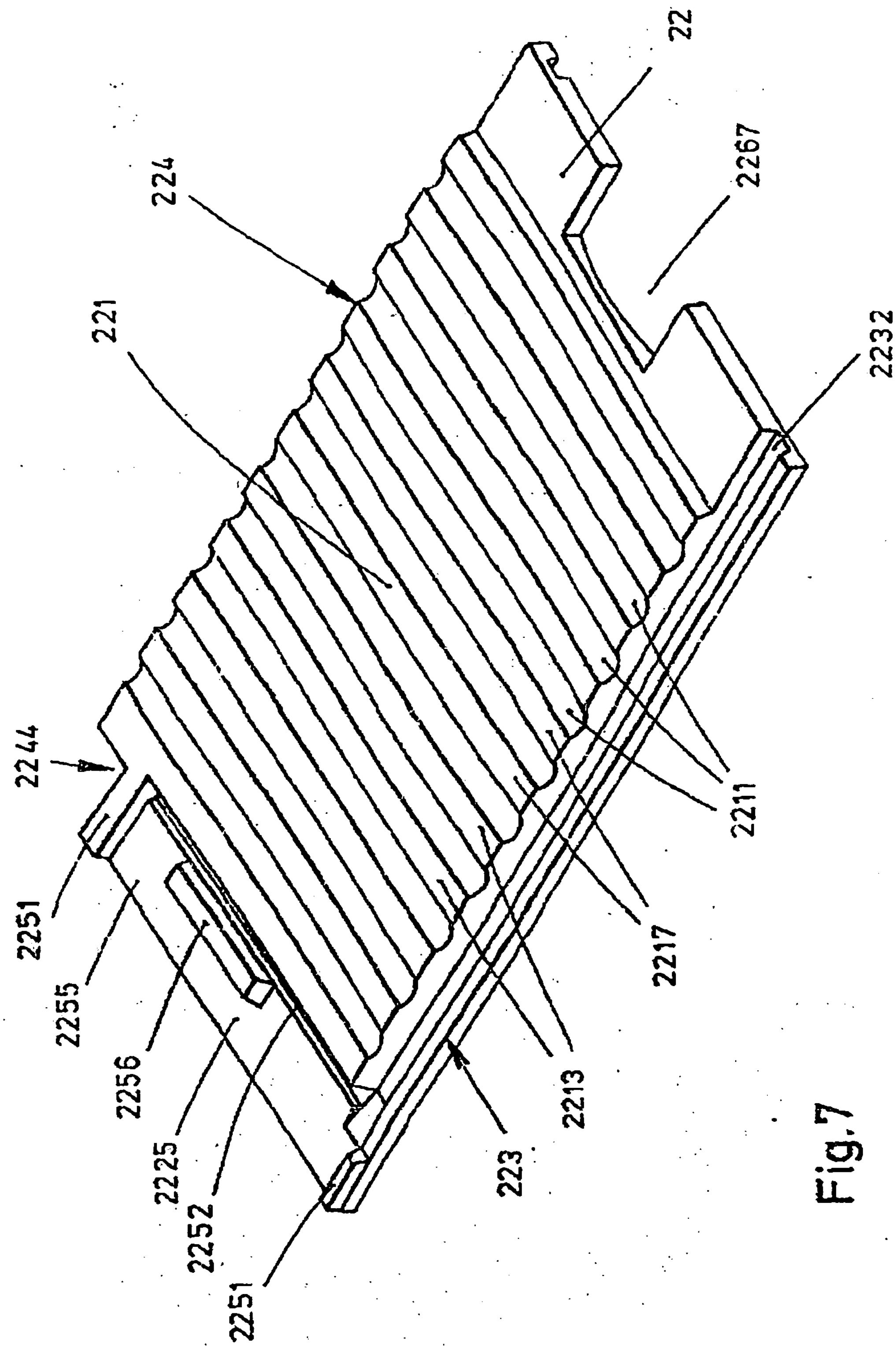

Fig.7

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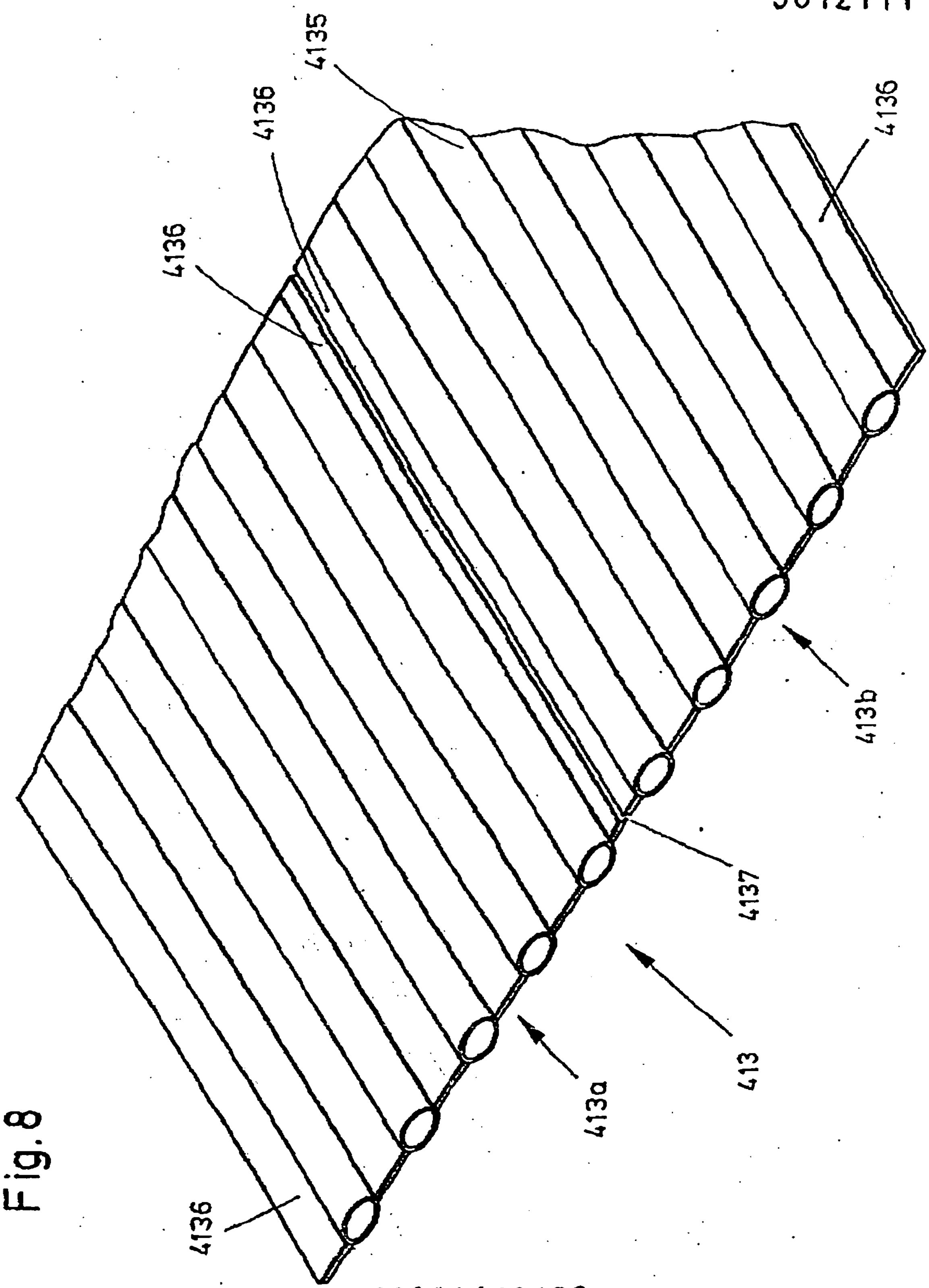

Fig. 8

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Fig.11

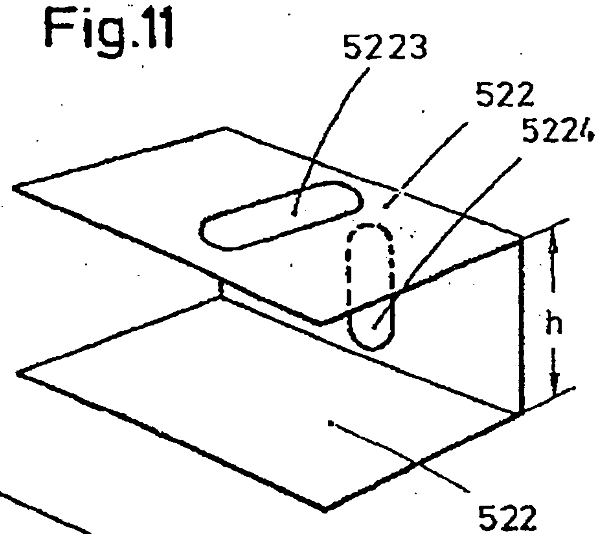


Fig.10

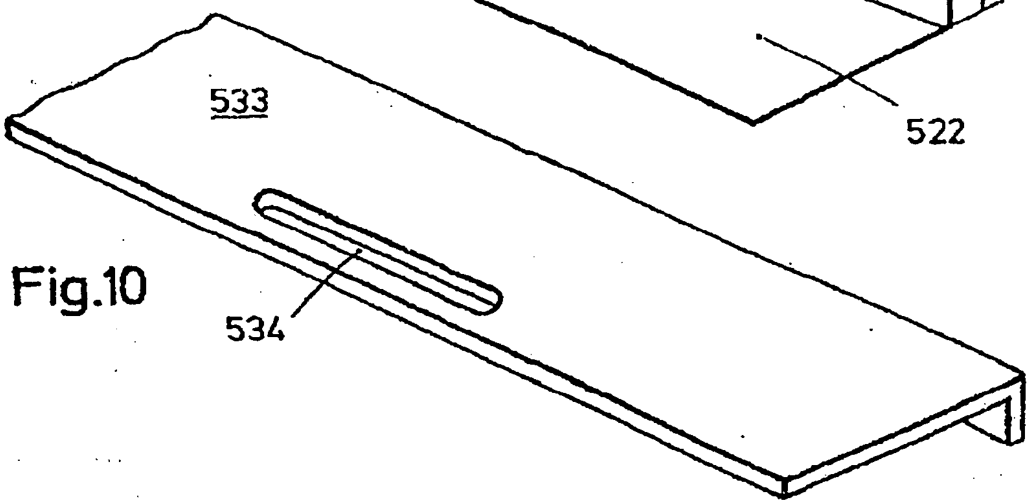
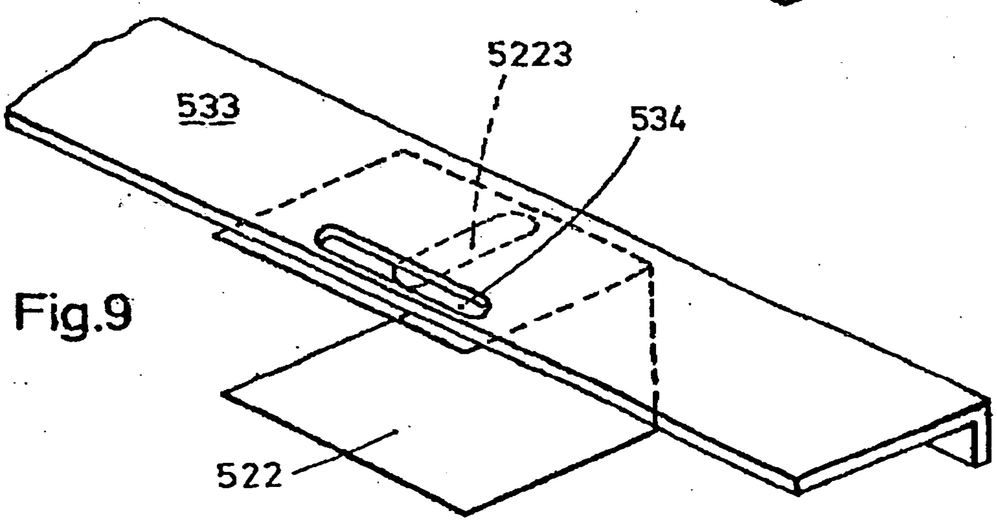


Fig.9



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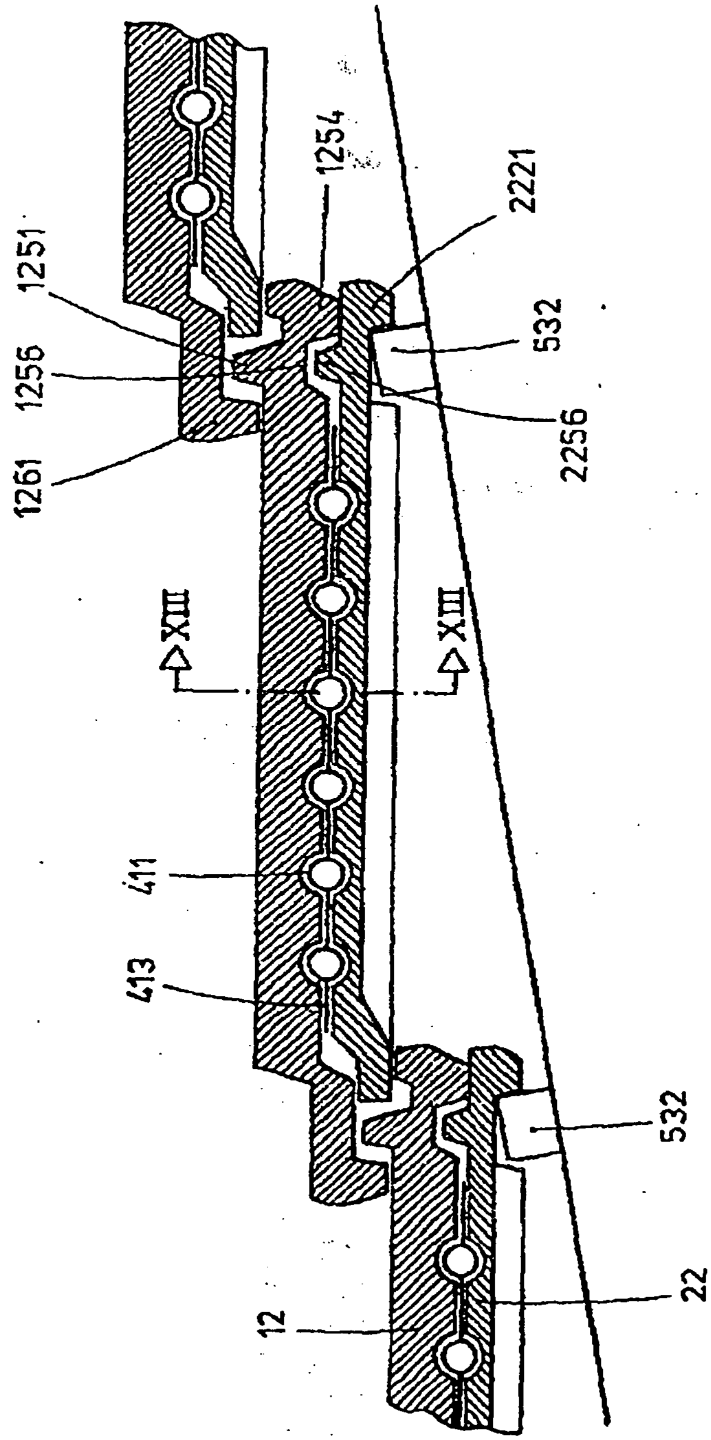

Fig.12

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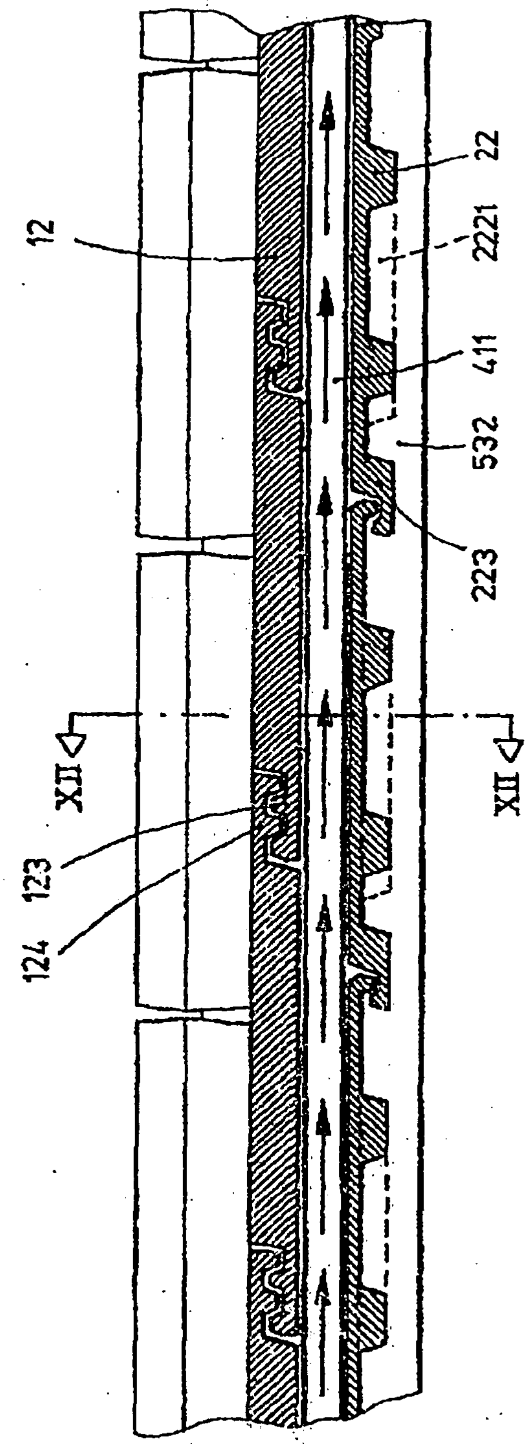

Fig.13

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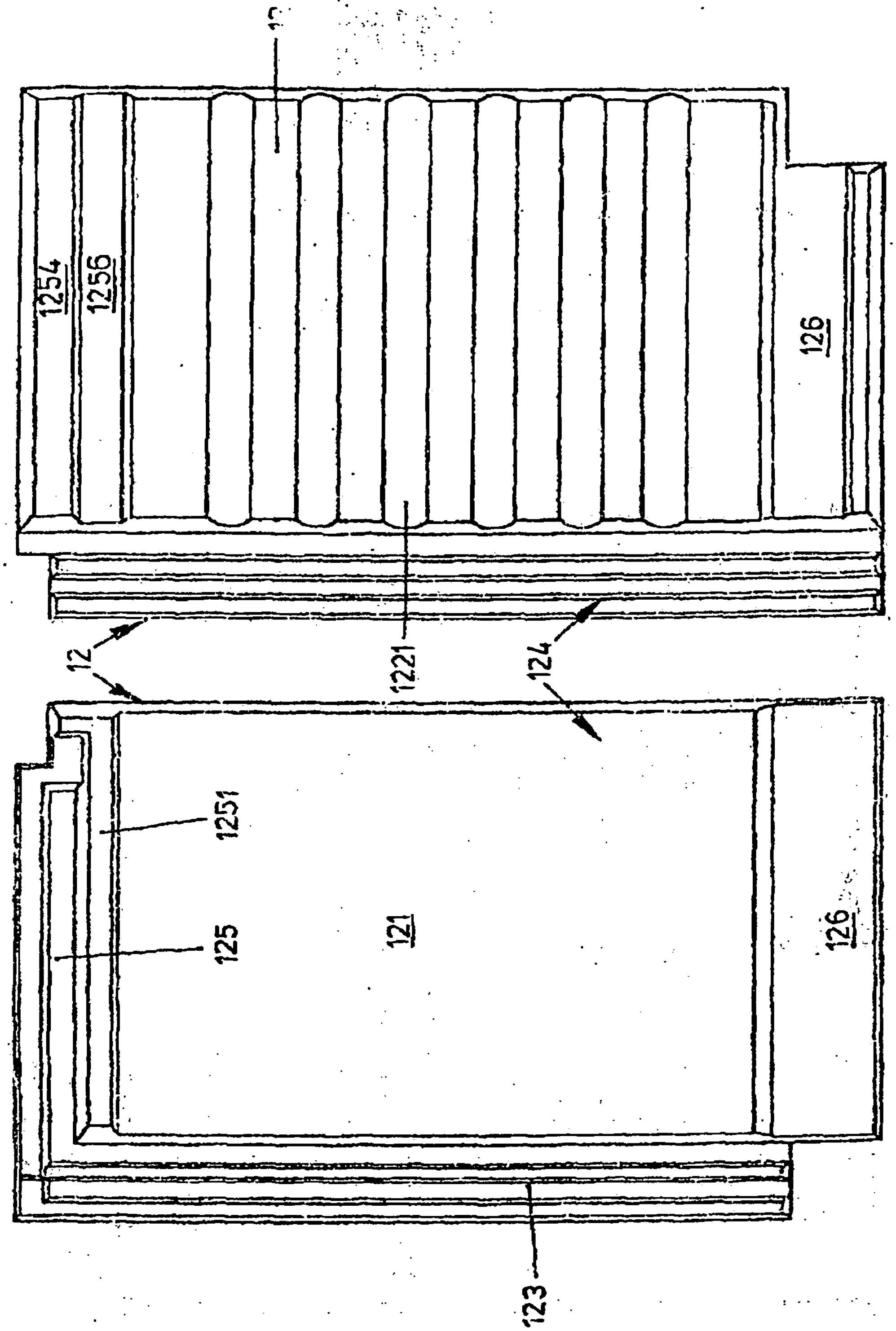
Fig.15

Fig.14



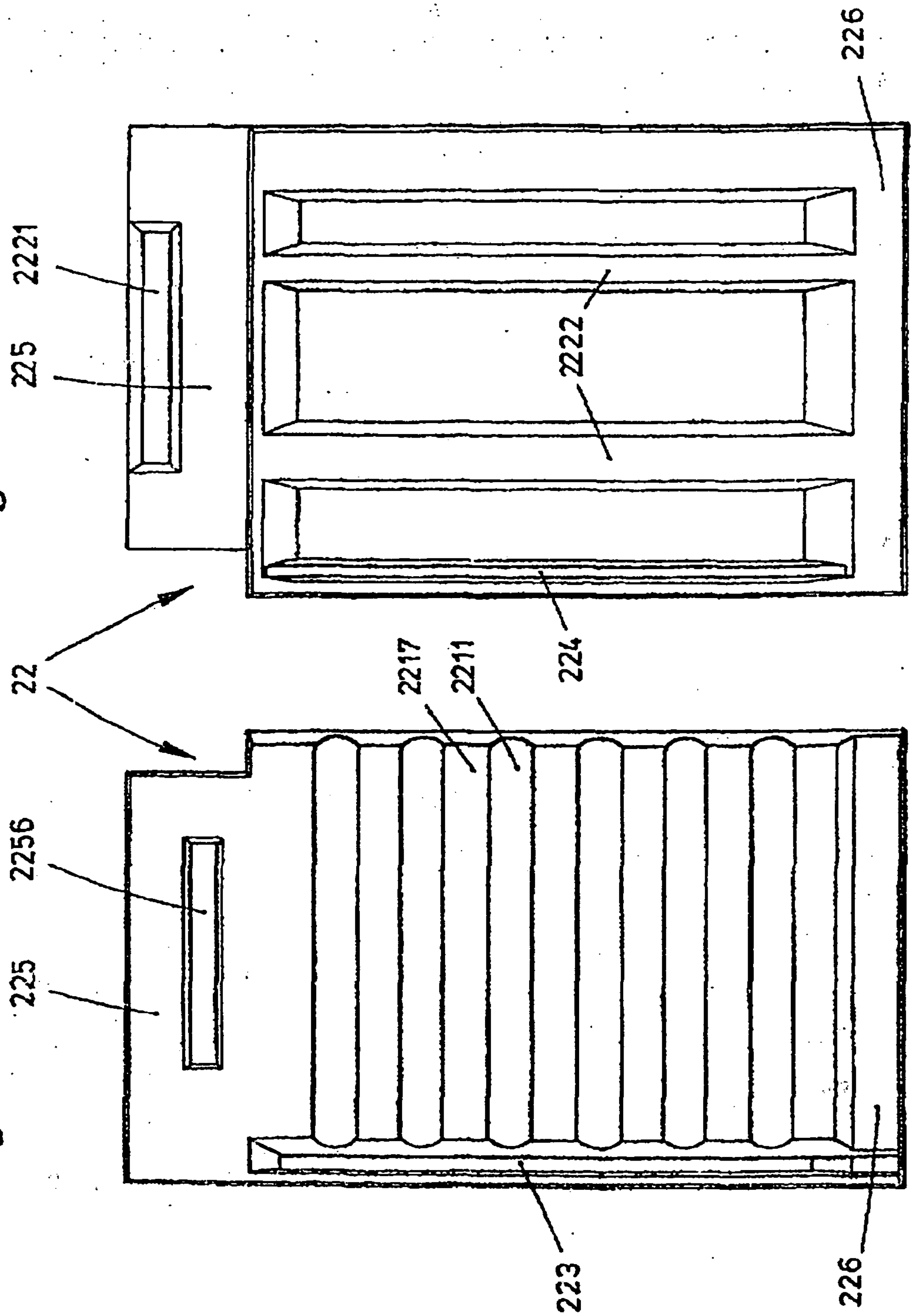


Fig.17

Fig.16

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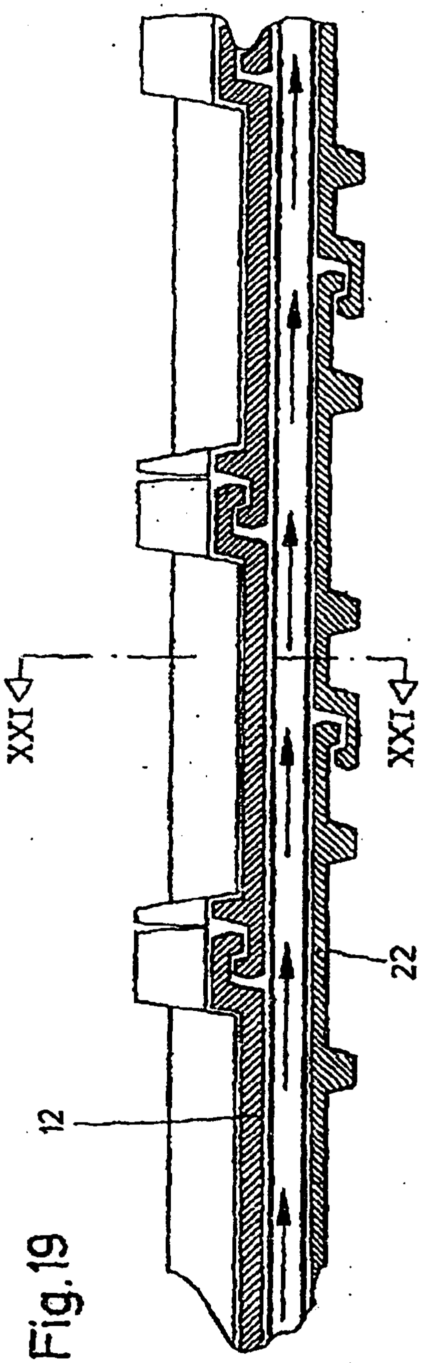

Fig.19

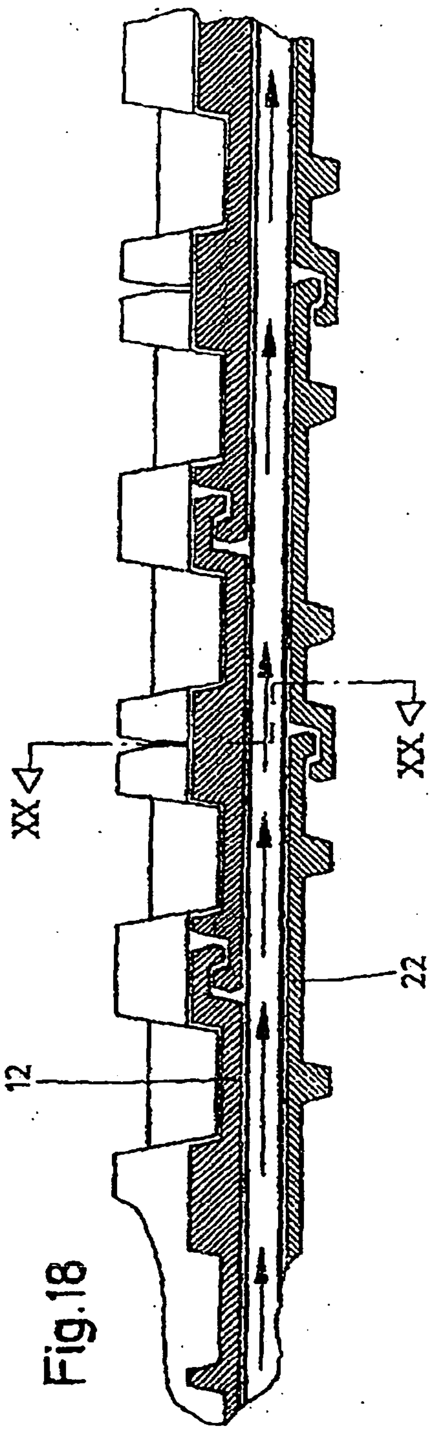

Fig.18

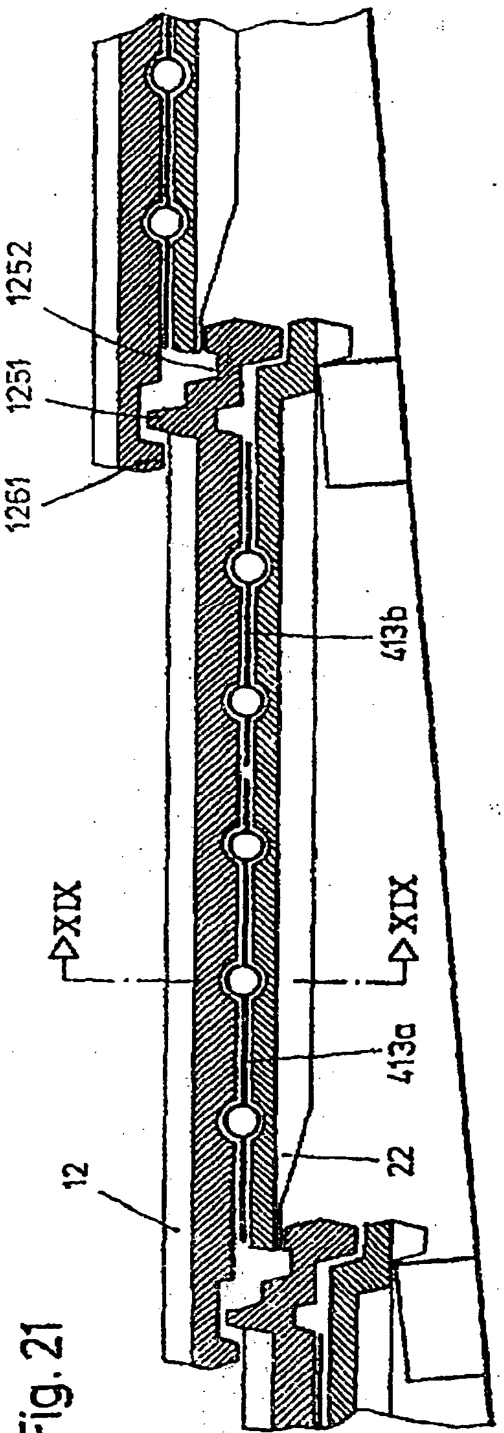

Fig. 21

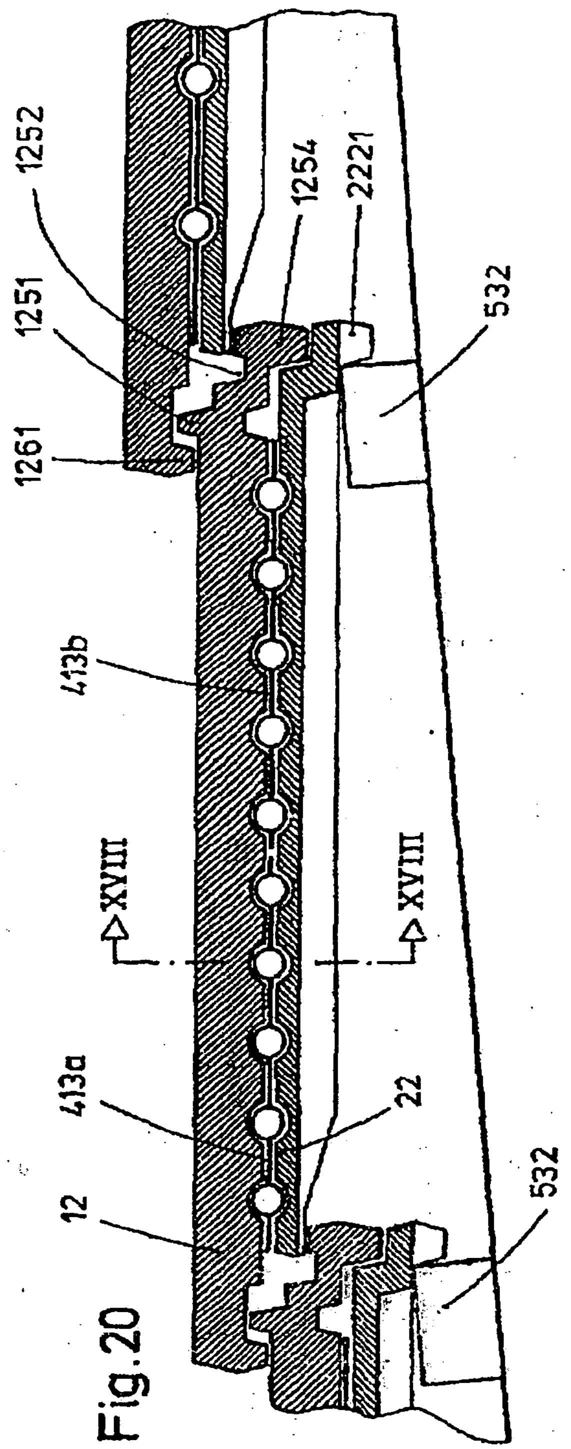

Fig. 20

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Fig.22

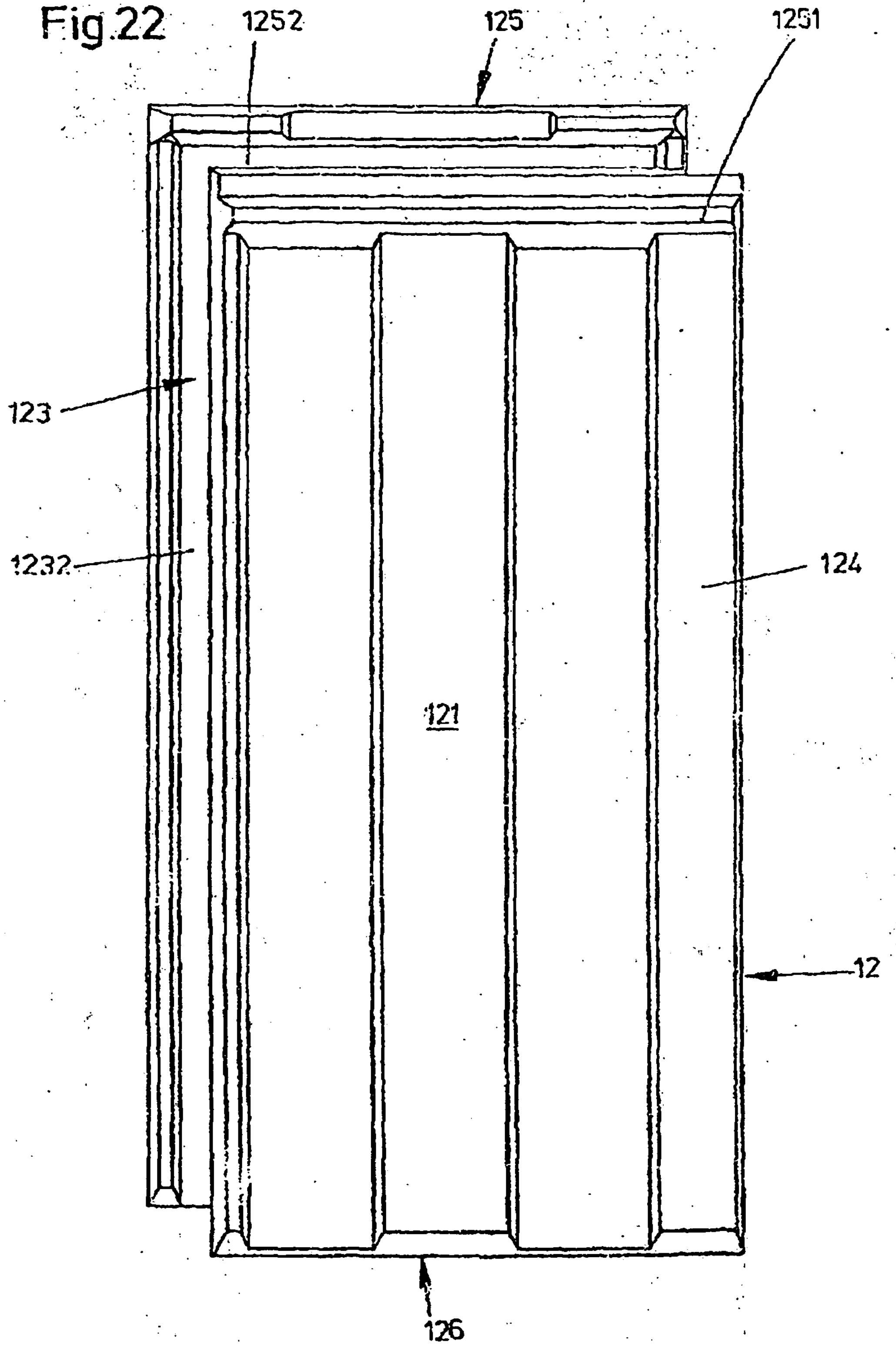

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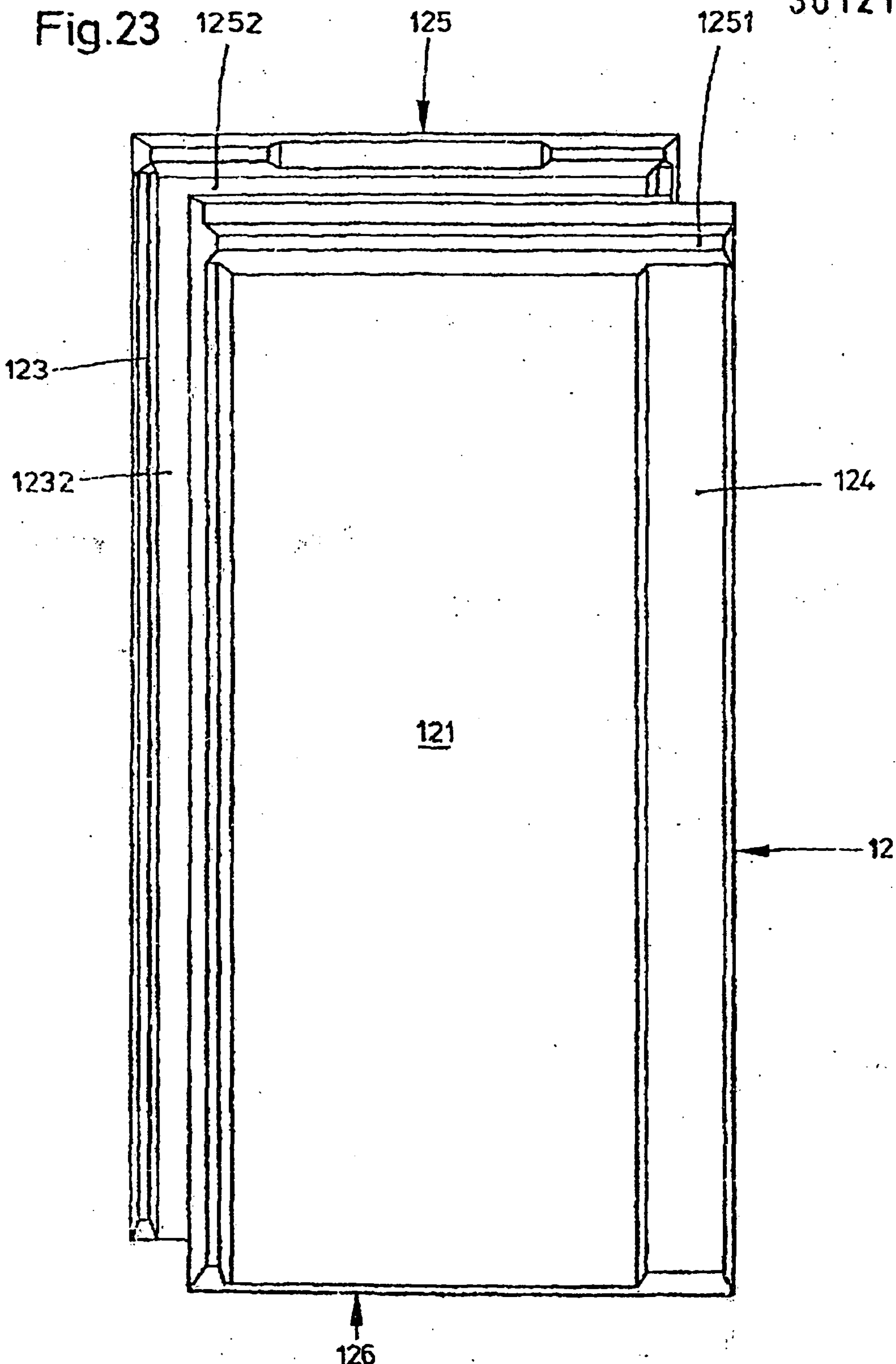
Fig.23



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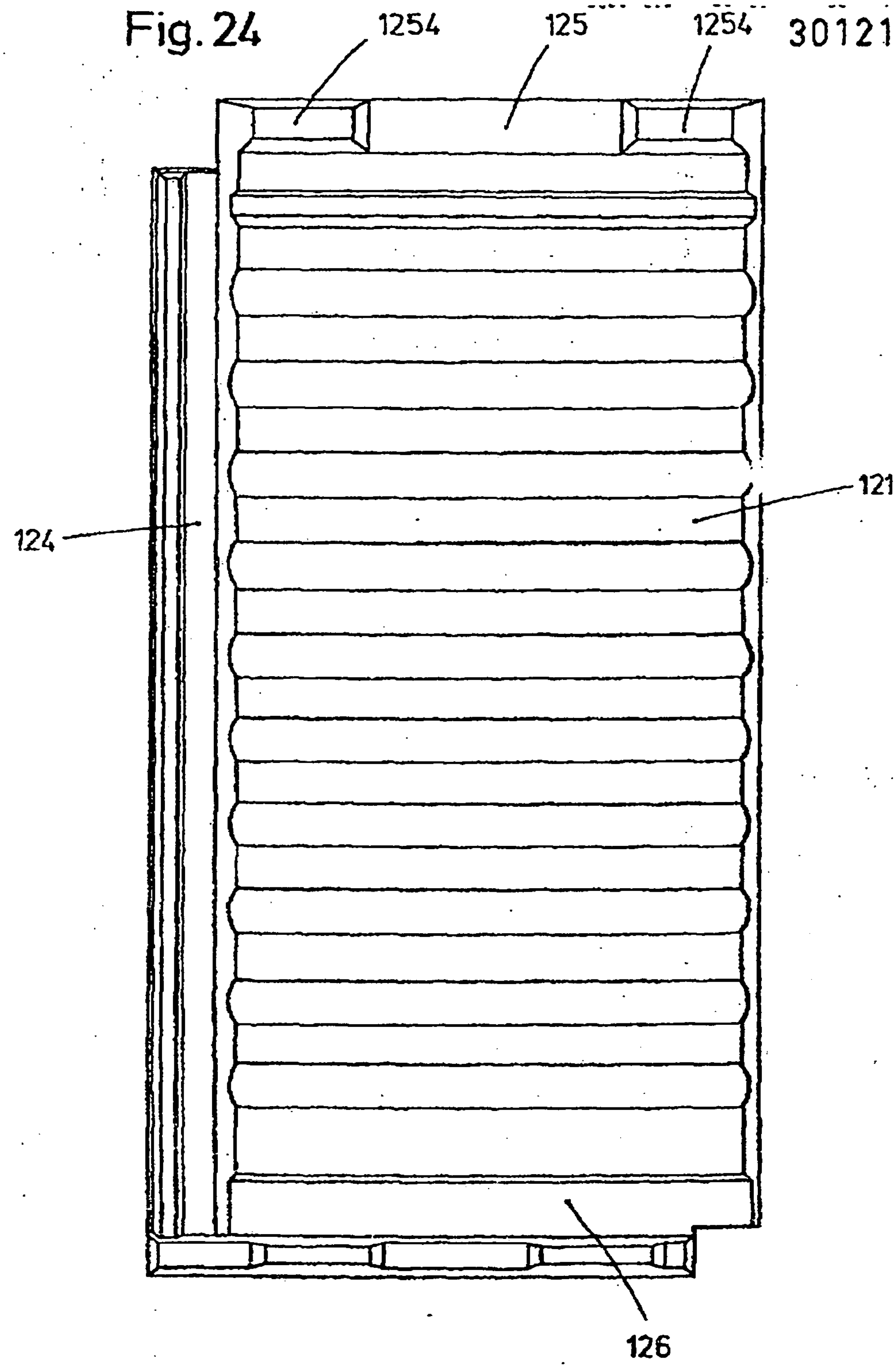

Fig.25

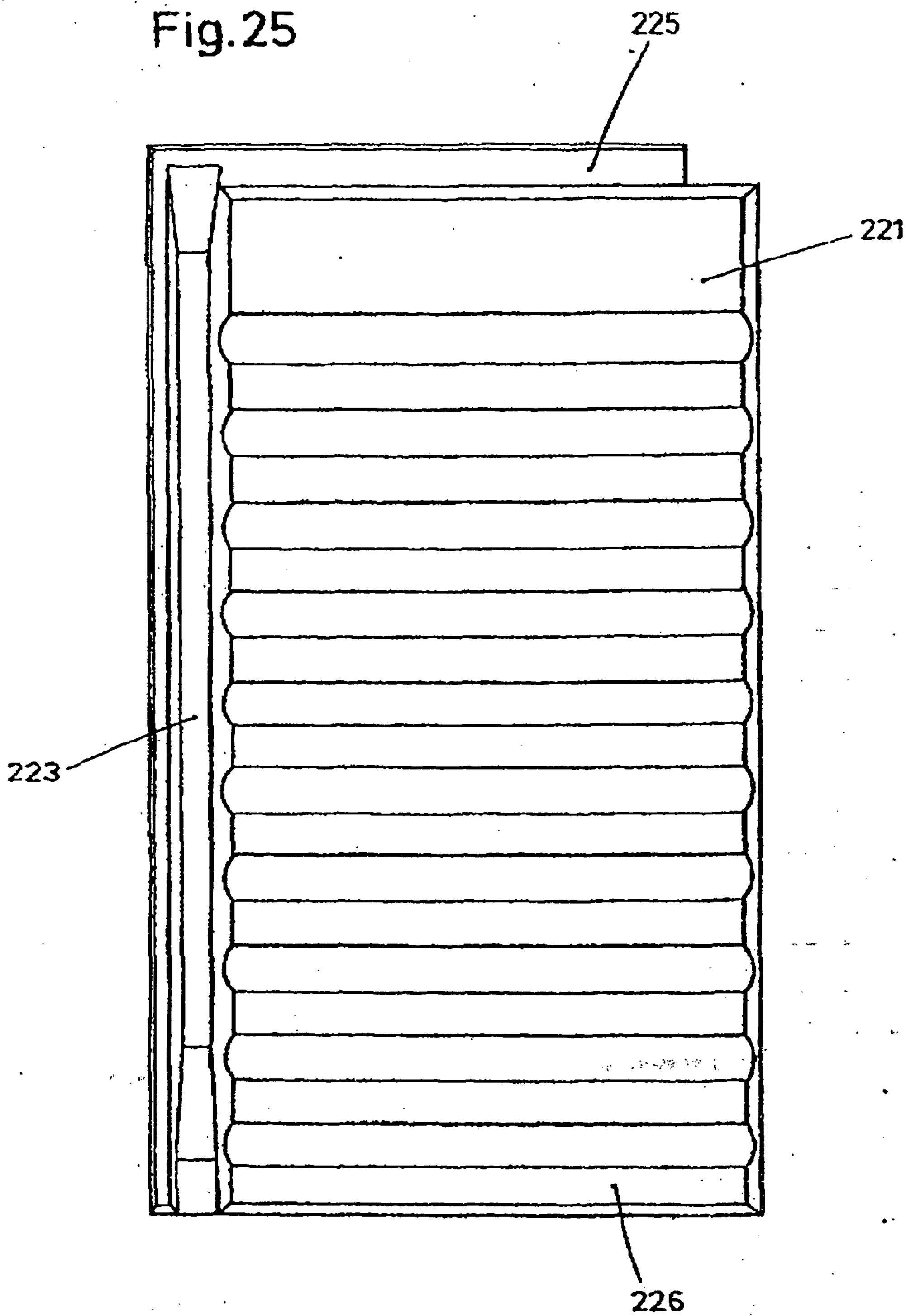

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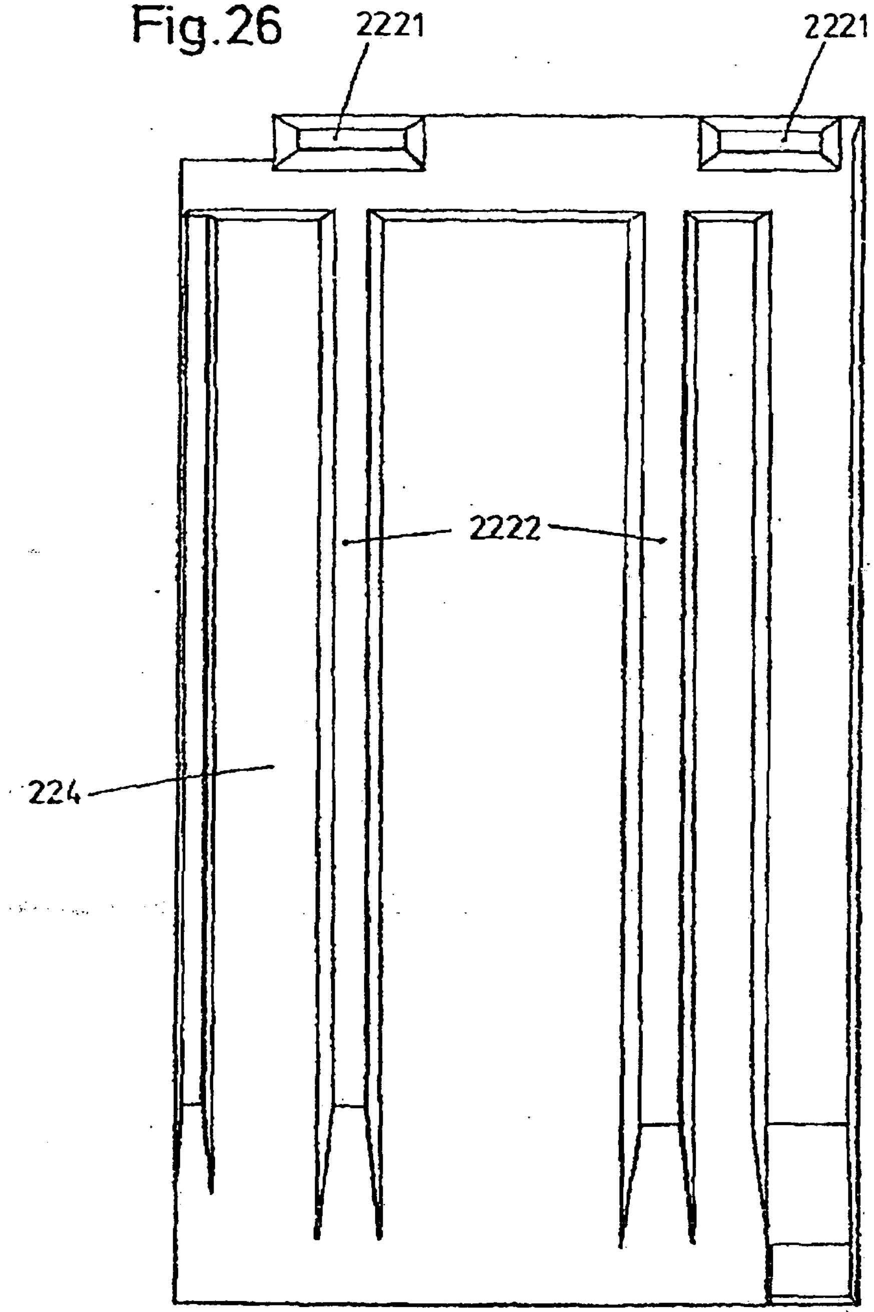
Fig.26



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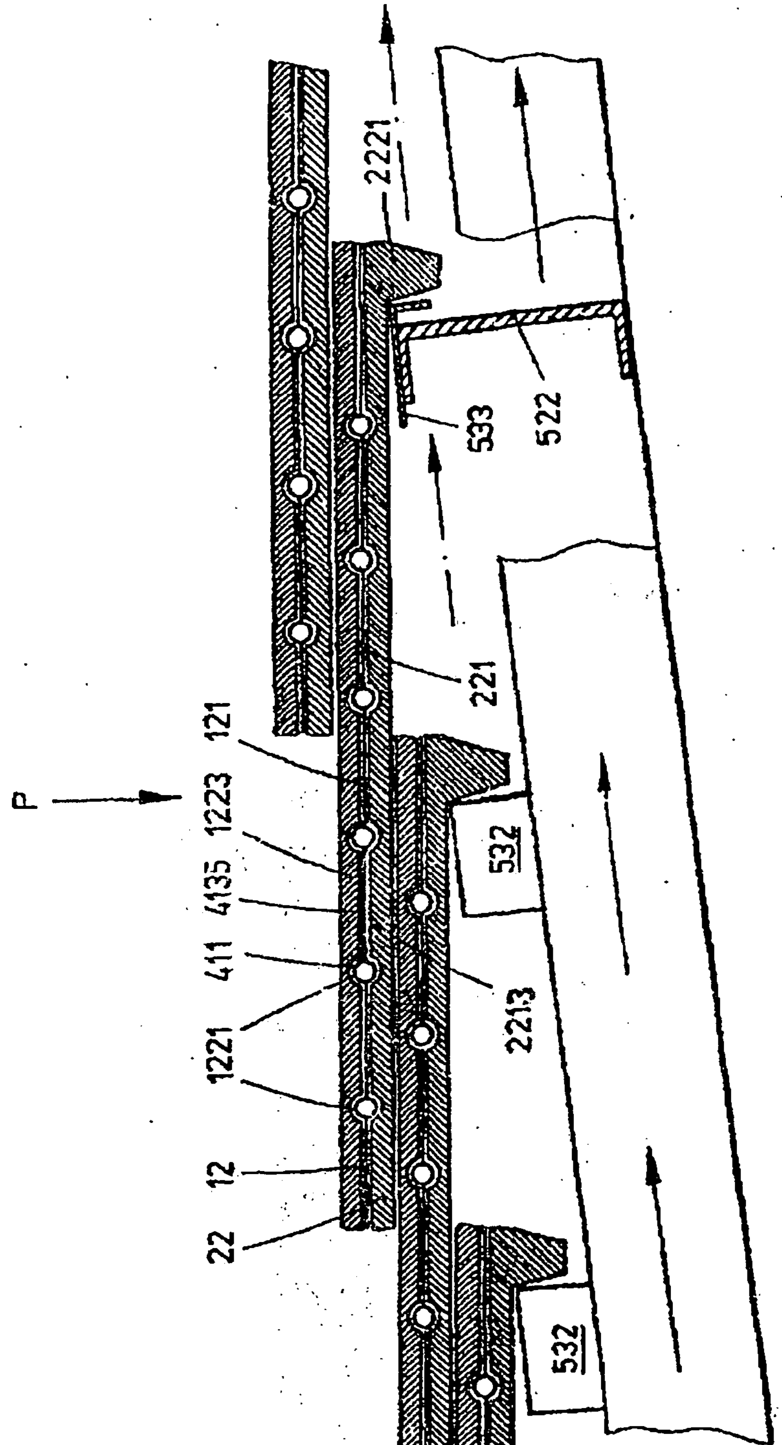

Fig. 27

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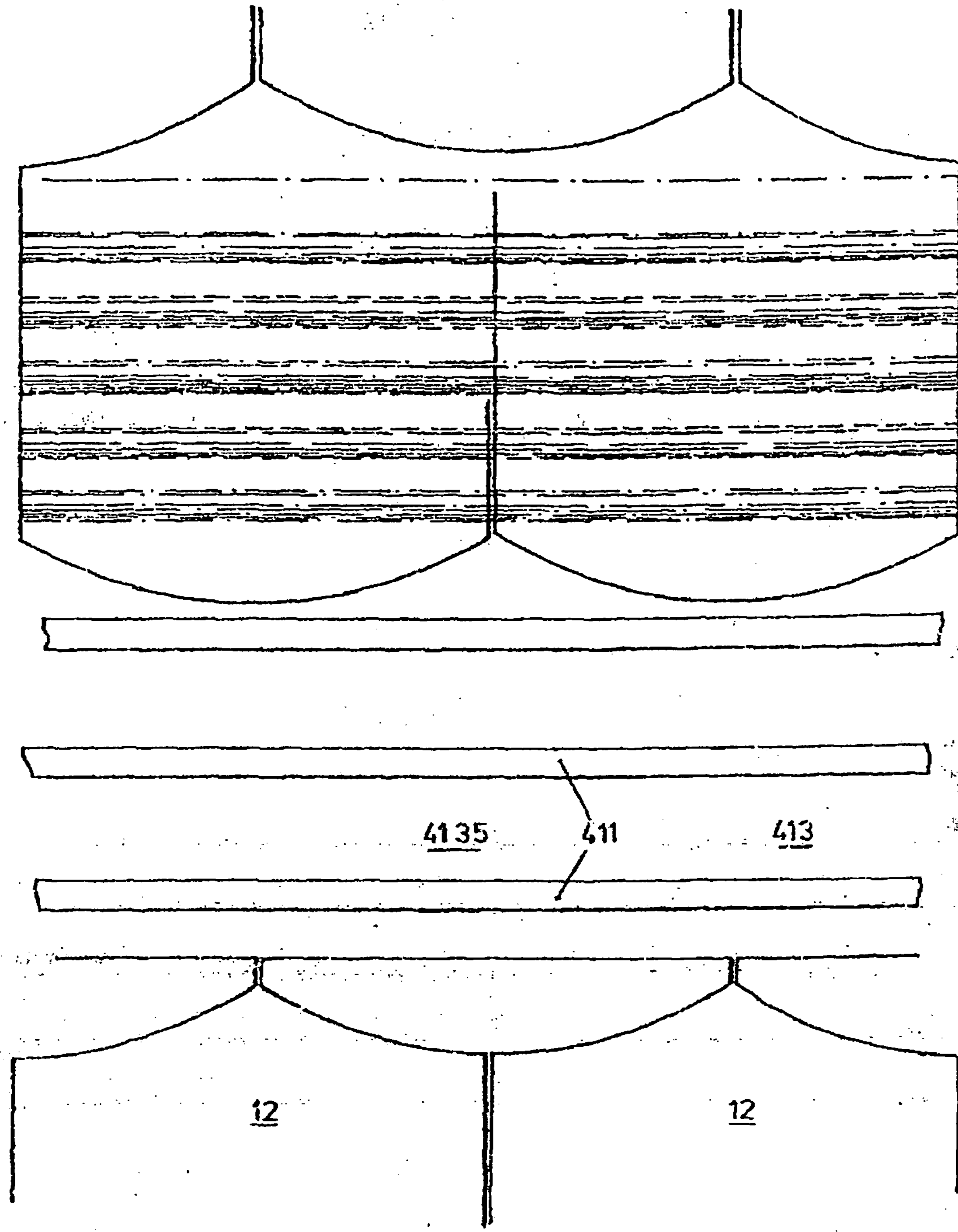
Fig. 28



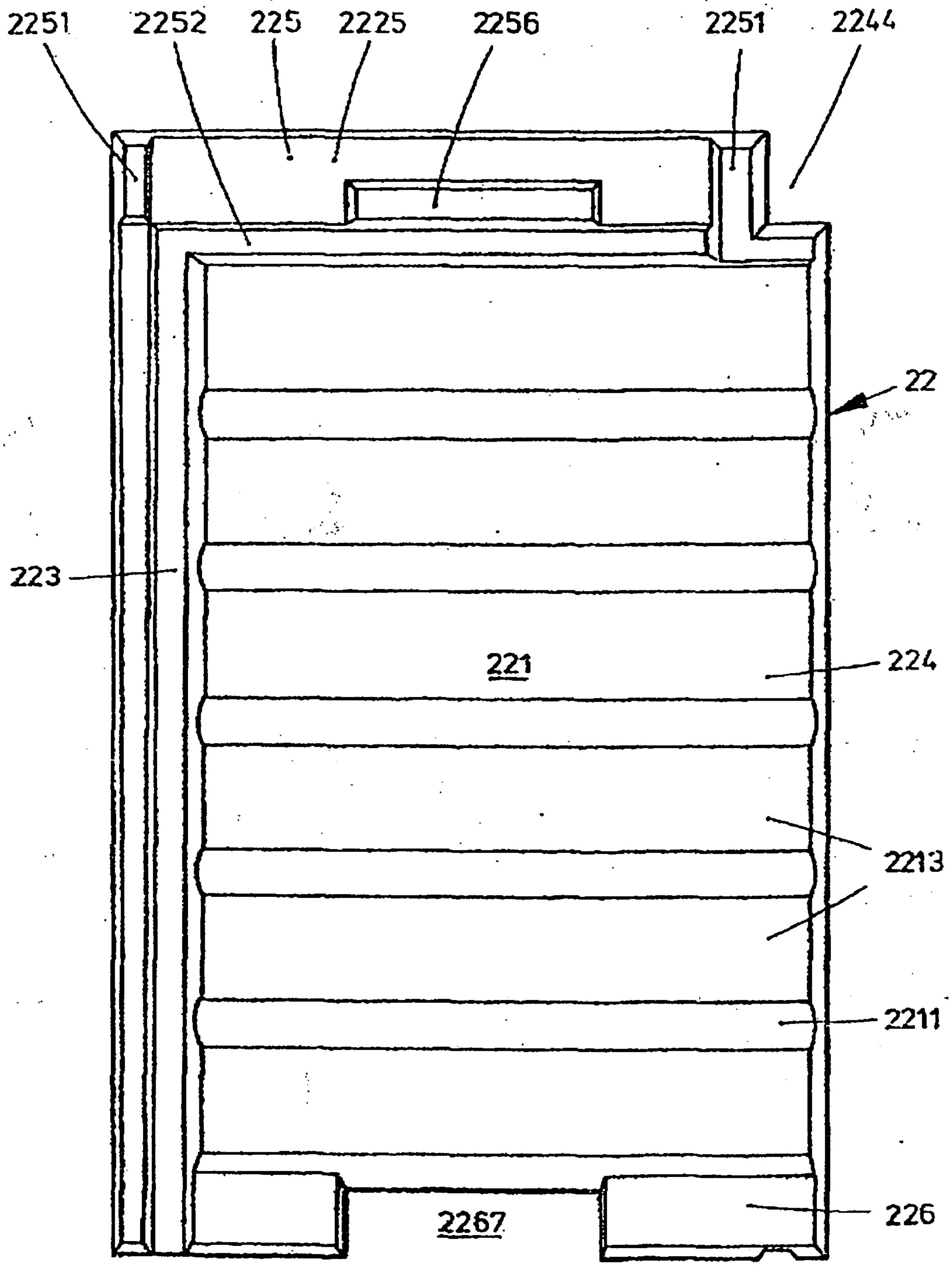


Fig. 29

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Fig.30b

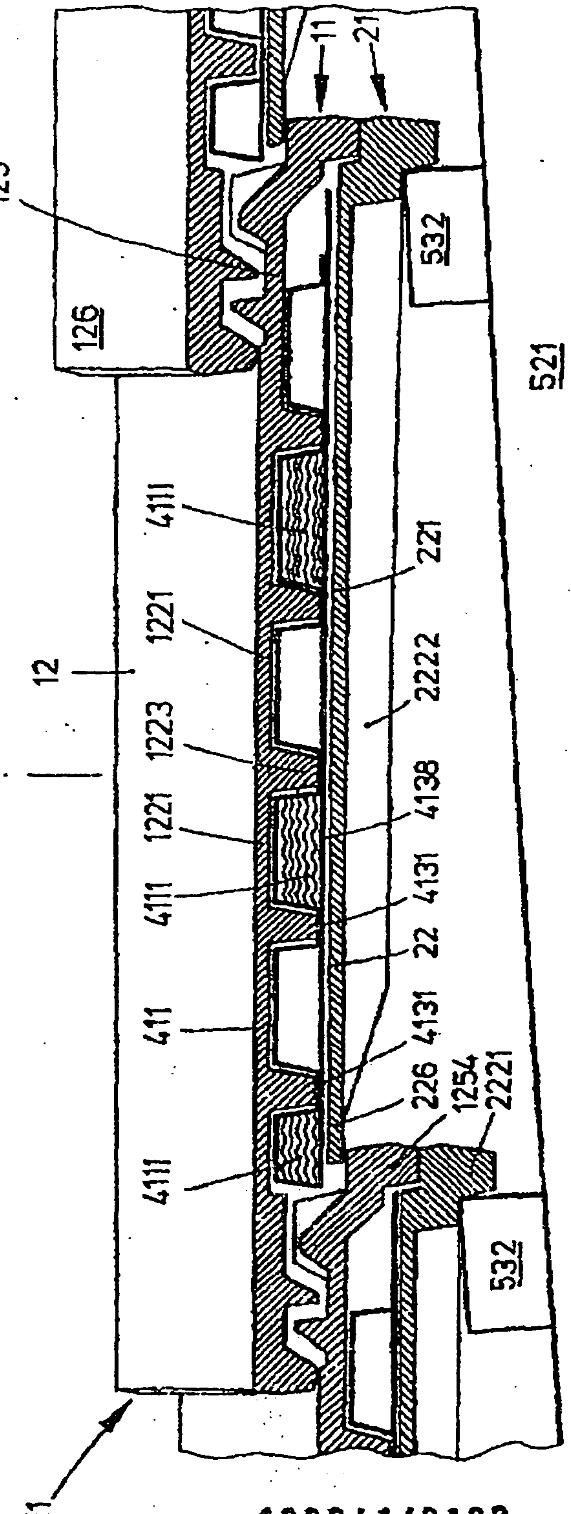

Fig.30a

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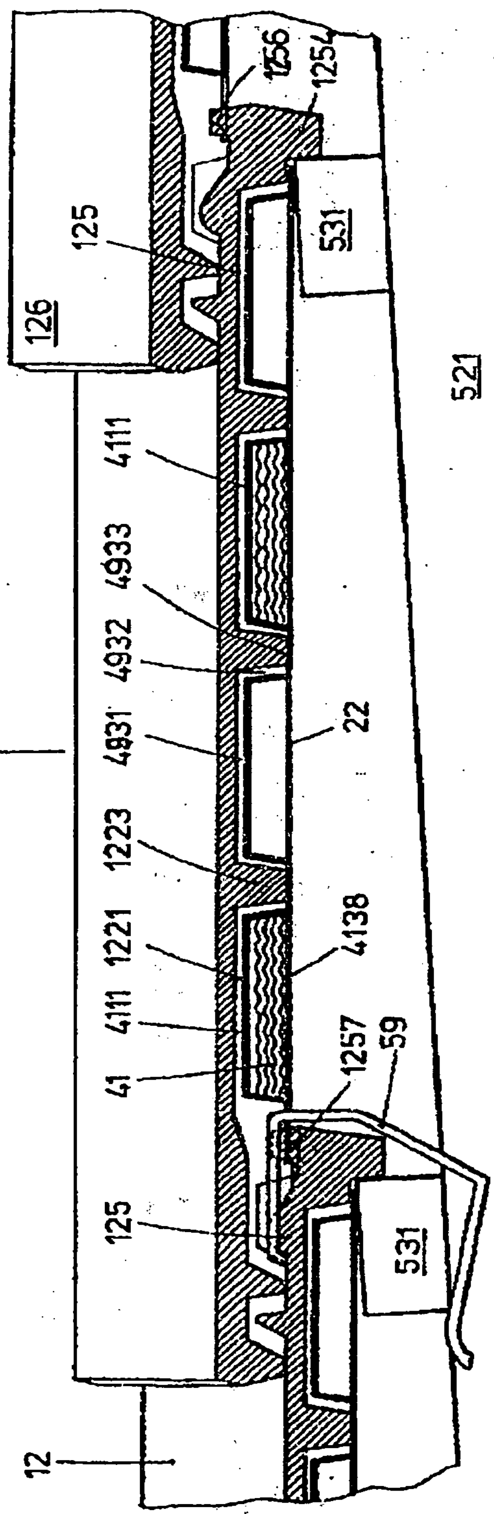

Fig.31b

Fig.31a

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Fig.32b

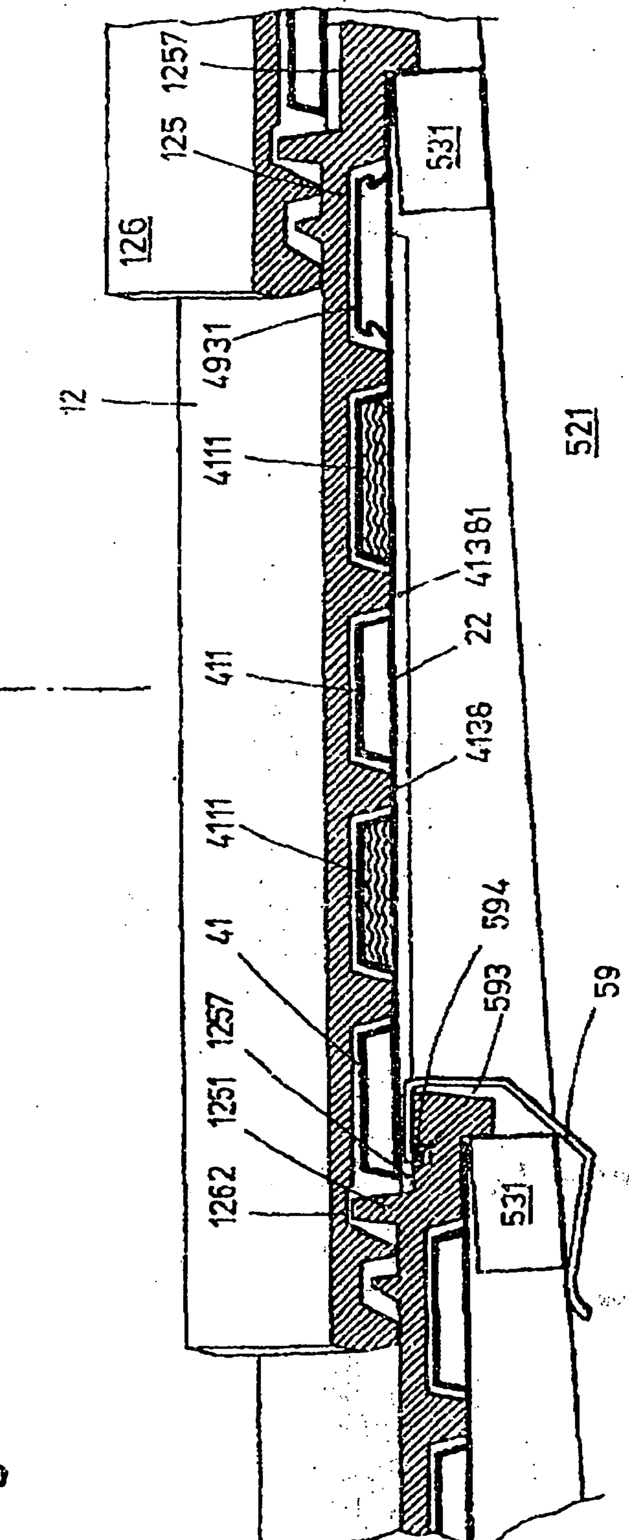

Fig.32a